SUPPLEMENT TO
FORESTRY
THE JOURNAL OF THE SOCIETY
OF FORESTERS OF GREAT BRITAIN

THE DEVELOPMENT OF PULP AND PARTICLE BOARD INDUSTRIES AND THEIR EFFECT ON FOREST MANAGEMENT

WITH SPECIAL REFERENCE TO THE SANDWELL REPORTS

Report of Discussion held at Lyndhurst November 1959

Published by the
OXFORD UNIVERSITY PRESS
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Price 5s.

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Chairman: SIR HARRY CHAMPION
Boars Hill, Oxford

Secretary: J. J. MACGREGOR
Imperial Forestry Institute

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Oxford University Press, Amen House, London E.C.4

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PRINTED IN GREAT BRITAIN

FOREWORD

THE discussion reported here was modelled on three previous discussions convened independently over the previous three years at Attingham Park, Shropshire, Dartington Hall, Devon, and Northerwood House, New Forest, by Lord Bradford, Mr. Hiley, and Sir Henry Beresford Peirse respectively, the subjects being *The Coming Age of Wood*, *How Should We Grow Conifers?*, and *The Management of Coniferous Crops*. At the last of these it was thought that they had been fruitful enough to suggest the desirability of setting up some more permanent organization to convene similar meetings from time to time as appropriate subjects came to notice. The Society of Foresters of Great Britain undertook to do this and, after discussion, thought that the development of wood-based industries, as a matter of foremost importance, was particularly suitable for discussion between the foresters who grow the raw material and the industrialists who may use it. The timeliness of such a discussion was underlined by the publication of two reports by Messrs. Sandwell & Co. Ltd., Consulting Engineers of Vancouver, Canada, one commissioned by the Organization for European Economic Co-operation dealing with the potentialities for a small pulp mill in the United Kingdom, and the other commissioned by the Forestry Commission making a similar survey of board-mill possibilities.

As the Society includes few industrialists in its membership, invitations were issued to several leading personalities to join in, and we are greatly indebted to Dr. Frankel, and Messrs. Budden, Edwards, Hollingsworth, Lynam, Pritchard, and Troup for their co-operation and valuable addresses. About forty members were present, four of whom, Dr. Chalk and Messrs. Rendle, Ryle, and Wilson, presented prepared addresses, whilst all took part in the discussion. It should be noted that one departure from the intended sequence of speakers proved unavoidable; Dr. Frankel did not actually speak first, but after Mr. Pritchard. The first draft of the text was checked against tape recordings. The names of those who attended are given on p. 68.

By courtesy of the Forestry Commission the meeting was held at Northerwood House at Lyndhurst, New Forest, which has exceptionally convenient facilities for a gathering of this kind.

At the conclusion it was strongly recommended that a full report should be published and that further such discussions should be planned.

For this first meeting, the Society thought it desirable that the President should take the chair, and Mr. J. J. MacGregor of the Imperial Forestry Institute kindly undertook to act as Secretary, which task involved much correspondence over the arrangements and labour in preparing this report for publication.

HARRY G. CHAMPION

Oxford
15 *December* 1959

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I. VIEWS OF INDUSTRIALISTS

(*a*) THE DEVELOPMENT OF THE WOOD PULP INDUSTRY

By T. H. FRANKEL

DR. FRANKEL said that he was not present to defend Sandwell Co's Report, the limitations of which one might understand better were the history of their appointment known. For many years people like himself had said to the Forestry Commissioners and private owners that a pulp mill in this country could only exist if it were big and efficient. It was hopeless to expect Britain to build one small pulp mill after another as wood became available in an area. The Forestry Commission did not like this; it was an inconvenient thought, and they thought they should get an independent person with an international knowledge of the pulp and paper industry to verify whether or not the views of people like himself were correct. The terms of reference were not to advise the Commission and the public on the best way of utilizing wood which might become available in the future, but about the economics of a small pulp mill. Sandwell was not asked to say whether or not a small pulp mill would be good, and his findings could really have been expressed in a few lines. He could have said a small pulp mill was uneconomical, and if a small pulp mill was wanted then the wood would have to be supplied very cheaply. In effect, the Sandwell Report emphasized that the smaller the mill, the less efficient it would be.

Dr. Frankel understood that he had come to talk particularly about *softwood utilization in the north*. He had some experience of softwood and was responsible for the buying policy of raw materials, including wood pulp, of the Wiggins Teape Group who were the largest buyers of bleached pulp in Europe. He thus knew something from the receiving end of buying pulp, and when Sudbrook sold pulp to the above group, that meant selling it to themselves. He also knew what it meant to compete internationally with the suppliers of pulp, whether they were in Finland, Norway, Sweden, Canada, or the U.S.A., the countries from which they bought their wood pulp.

Recently they had invited three of their biggest colleagues in the industry in this country to join them in an investigation in Scotland, and so he had also come to the meeting as the person in charge of the development work in the north.

Sandwell said that a pulp mill had to be highly efficient, otherwise it would not be able to sell its pulp to the paper mills. He also talked about integrated pulp and paper manufacture, referring specifically to newsprint. Many would wonder why it was not possible to build a newsprint mill in the Scottish Highlands along with an integrated operation which, as the report quite rightly showed, could afford to pay higher prices for wood than could a separate operation. There would be no newsprint mill in this country, and even if there were one, it would not be built in the Highlands. The only justification for making newsprint in this

country would be in order to be at the doorstep of the consumer. A newsprint mill would have to be on the outskirts of London, of Lancashire, or of the Midlands or some similar situation. No one would dream of putting a newsprint mill in the Scottish Highlands when it might just as well be in Norway or in Finland or somewhere in areas where the wood supply was ample and, most important, power was cheap. He repeated that no newsprint mill would go to Scotland. He had nothing to do with newspapers—but the newsprint mills in this country were very well run: they were led by very efficient industrialists; if there were a possibility, or an economic likelihood, of building a newsprint mill in Scotland, someone would have done it already. So one was left with the problem of building an independent mill and, as he had said, an economic one.

Over the Scottish scheme he was in a very different position from Mr. Lynam who said that for board manufacture the wood had to be delivered at a certain price. If those who grow trees in Scotland, whether the Commission or private owners, wanted a pulp mill, then it would have to be on such a scale, and to be supplied in such a manner that it could be as profitable as a new mill in Scandinavia. This is what he had said to the Forestry Commission years ago, before the Sandwell Report, and he still said the same. Now, perhaps, he was even more pessimistic than before. At that time he was convinced that a mill as efficient as a Scandinavian one could exist in this country. Today, and for the last few years and probably for many years to come, the price of pulp was very low. He wished he could now be as sure as he was a few years ago. There were quite a number of industrialists abroad who held the view that one could not economically build a new mill on the basis of present Swedish wood prices. The price had to be lower than in Sweden—as for the new big mills in America—to justify a completely new mill. However, he did not want to be pessimistic; he still held to the view that it would be feasible to build a mill in this country if it could hold its own in manufacturing costs against a Swedish mill to be built tomorrow. The Swedish standard of living was about the same as here, and while some things were higher in price, some were lower—power was definitely lower—but on the whole he thought the countries were comparable for general living standards and costs. Whatever the price of wood delivered to a pulp mill in Sweden might be from time to time, Scotland would have to compete with it; and if it could not do so then a pulp mill would not be justified.

The paper-makers of this country were not desperate to have a pulp mill. Pulp was available in first-class quality all over the world. They did not need a mill, so why did they come along? Why did they form a Development Company? Why had he, having done so much of the initial work, induced his company to invite three other companies to join in? Their reason was that they thought that it was their job as paper-makers to find an economic use for the available wood if that was what the foresters required; they would not be unhappy if there was no mill. They also thought it was their job to tell the Government and the public if and why it could or could not be done. His Chairman, when they started the Sudbrook mill, once referred to it as the 'National Service Department'. Well, he thought that was an honour, and he did not complain about that attitude.

They had enough knowledge and enough ideas on how to make a comparatively small mill based on hardwood in Sudbrook. They had, however, no such ideas for Scotland. They could not see any hope of building a small mill in Scotland. What would the capacity of a Scottish mill have to be? It would have to fit, not the available supply at the moment, but the available supply in 5, 10, or 15 years' time. Because, if one could build a mill small enough to fit the supply available now, then in 5 years' time it would be too small. A modern pulp mill was not a unit to which one could add further parallel streams; it was not, for instance, like a weaving shed which could be made a bit bigger 5 years later by adding a few more machines. A modern pulp mill consisted of one stream only as at Sudbrook where if any one little thing went wrong, as it did occasionally, the whole mill stopped. If one wanted to make something bigger, all that they could do would be to duplicate or triplicate the whole. So the Scottish pulp mill would have to be big enough to absorb all that was likely to be available for some time, and this meant that at first it would have to be too big. It was quite a problem to find a site which fitted the geographical distribution of wood and had rail and road access and water supply, tidal water for shipping, and such essential requirements. They thought it should be tackled, not on the basis of one company, but by joint effort and by letting the major part of the paper and pulp industry invest in it and see whether or not a success could be made of it. They had been very careful not to invest any permanent money in the scheme until it had been fully investigated.

There were really three sets of organizations which could create a pulp mill. There were the financiers, the people who wanted to invest money for the sake of profit, without a direct interest in the industry; he did not think anyone of this type would be attracted to pulp-making, as they had not been attracted to pulp-making anywhere in the world. The foresters could build a pulp mill as had happened in many countries on a very large scale; probably the major part of the pulp mills of the world had been created by the forest owners who were looking for an outlet for their wood, and the foresters here might do the same. The third possibility was that the users of the pulp could make the investment. They were at least the market; so there could either be an organization which controlled the supply of wood or one which would absorb the pulp.

He emphasized that he had some practical experience of the problems of starting a new pulp mill. The first few years of a new mill were terrible. Quite apart from the initial financial loss—and much money had been lost at the beginning—there were the worries, the difficulty of training personnel, and things like that. In Sudbrook there was not one man who had been in the pulp industry before they started production. They had to train themselves. They had to train every man; they had to learn the process which, at Sudbrook, was entirely new. So it was essential that one either controlled the supply or the absorption of the output, but he did not know which he would choose. If the paper industry built the pulp mill, it would at least be sure that there would be no difficulty in marketing the product.

They had been asked a number of times what the influence of the Outer Seven Scheme on the existence of such a new pulp mill would be. As pulp was at present

duty-free, the scheme would not affect the existence of a pulp mill in the United Kingdom. The only connexion could be that the paper industry, as a whole, would obviously be weakened by the Outer Seven Scheme. The paper industry would carry, perhaps together with the producers, the brunt of this development. In so far as they would be weaker, they would not be quite so ready to 'carry the baby' as they might have been in the days when they had more reserves.

Now where did they go from there, and what were they really investigating? This investigation would take a year, or something like that, during which they would have to look at every technical and economic angle of the scheme. They had started to study the pulp-making characteristics of the wood as it grew in Scotland. They would hear about the structure of wood in relation to pulp. He was not sure whether, from the practical point of view, and from that of the growers, it mattered very much. In this country the paper industry would always receive from home-grown sources only a small fraction of its fibre requirements. At Sudbrook only 15 per cent. or so of the fibre requirements of the group was home-grown, and they could thus choose the quality of the fibres bought from abroad to adjust the blend. Some time ago there was much argument and correspondence in one of the journals about the influence of wood structure on pulp-making and the quality of the product, and he had suggested in a letter to the editor that the foresters should agree what was the most economic for them to produce. They need not worry about the pulp-maker whose job it was to make use of what the producer grew provided he grew what was most economic; this means to grow to get the largest dry weight of wood per acre per year for the smallest capital expenditure. From the practical point of view the pulp-maker was not concerned whether the fibres which can be got from Scottish wood were of this or that type. Though it would influence the layout of the mill, might influence their process, and might even influence the economics of their process, they must start with the raw material available and had to devise their processes to suit that supply. Another fundamental they had considered from the beginning was that a pulp mill in Scotland would have to use a process in which all wood species could be used in whatever shape or form they came. He did not agree with Mr. Lynam as to the utilization of sawn offcuts. Mr. Lynam naturally thought of chips as the sort of chips which the particle board required; he himself thought of chips as the sort of chips that a pulp mill required—something quite different. All over the world, in countries where large sawmills existed, the bark was removed from the sawmill log before sawing. He had been told by the people who operate the sawmills that the saving in sawing time and in maintenance was sufficient to pay for the removal of bark. All the big sawmills could then operate chippers—not like those operated by Mr. Lynam—but chippers like those operated by pulp mills, only on a small scale. It was economic to transport these chips provided they had been made from offcuts which had previously been debarked as was done in Sweden, Finland, and America. So the first step for using sawmill offcuts was for a sawmill to be of such a size that it could afford to install a barking machine and chipper so that it could dispose of chips and offcuts, which were something like 20 to 30 per cent. of the original volume. He had been told that in Sweden,

where there was real competition, a sawmill which could not dispose of its offcuts economically to a pulp mill could not make a good profit. He was fairly certain that one day similar conditions would arise here.

They were studying in pulping, not the idea of refusing any kind of wood that was being grown, but how best to use it. For the moment he had assumed that this would not complicate the layout of the mill. They sought the specifications that would be most economical for the grower, the extracting organization, and the pulp mill. The specification for a pulp mill varied over the world in the most peculiar manner, being largely governed by tradition, and the mills had their equipment to fit local conditions. They were starting from nothing in the Scottish Highlands, with no traditions either in the forests or as to the pulp mill site. They had come fresh to those problems, together with those who were interested, in trying to define a specification which would be most economical in practice. The most important question was the tonnage that was available—not today, but in *x* years from now, and what the influence of capacity was on the capital and operating costs of a pulp mill. They must prepare a number of estimates for different sizes to determine the economic minimum. If they created a new unit and had to spend about £10,000,000 in creating it, then they had to be sure that it was a good one.

A very big problem was to organize extraction and transport in such a way that it was really economical. If we went on as we were doing, with small-scale expansion, or small plots, he was certain that there would be no margin left, and eventually there would be no pulp mill, because it would not be economical; and it would be left for them to think out what else could be done. He repeated that if foresters could find any other industry which could dispose of their products and give them a better return, they should please contact these other industries. But if a pulp mill were wanted, it had to be supplied economically. Many years earlier, in discussions with the Forestry Commission, he had warned Mr. Gosling, as he then was, about 'nibbling', i.e. the process of putting small industries in the one big area that might ultimately supply a pulp mill. It was necessary to make up one's mind either to reserve the big area for supply to a pulp mill and so make an economical pulp mill possible, or to fill it with smaller industries and forget the pulp mill. They should not try to do both. In the Scottish area which they were considering, one particle-board mill was already under construction. That was not big enough to shatter the scheme, but it was a factor which all those interested in the Scottish forests had to take into account.

It had been said that this method of investigating all the other alternatives first was the wrong method. As pulp industrialists they should have said: 'A pulp mill could pay so much, take it or leave it, goodbye!', and if the foresters did not like this offer then there could be no pulp mill. Dr. Frankel thought that this was quite wrong. The industrialists had to work out all the questions of capacities and specifications affecting the capital needed and the type of operating plant. Until this had been done they could not come down to the fine limits which they wanted to know before they could either take up the scheme or must abandon it. The Development Company had no staff, there were therefore no overheads. They

had merely borrowed the industrial effort of the four interested companies. Each of the four companies had taken on certain parts of the job and had contributed their best men. Apart from transport problems for both the wood and the finished products they had to investigate fuel, power, housing, and very many other things. There was yet another thing which might shock some of his audience; they had already told the Board of Trade and the Scottish Office that the pulpwood specifications adopted eventually by this scheme would have to be liberated from import duty. His audience might not even know that there was a duty on pulpwood, other than the specification which had been exempted to fit Bowaters' requirements as they then were. The specifications for pulpwood for a chemical mill were certainly different from Bowaters', i.e. from those mechanical for pulp. It could well be imagined that the public in Scotland, who were not very well informed on this subject, would be horrified that a pulp mill scheme asked for facilities for importing at the same time that the Scottish forests were crying out for an outlet. As he had already said, a Scottish pulp mill would have to be too big for the supply available at the beginning, so it would very probably be necessary to import as well. It might be possible though to pick up some pulpwood in southern England, say in the south-west where there was not a very convenient industrial use. Boats returning to Scotland might pick up wood there, but even so some pulpwood would have to be imported. This was to be regretted because imported wood was expensive—with prices very different from those of the National Coal Board for pit-props. The pulp mill would have to pay for pulpwood delivered in its yard the same delivered price as was paid at a pulp mill in Sweden. With pit-props, the argument seemed to be that one compared the delivered price of imported wood with the price for home-grown. This did not apply to pulpwood, and supplying pulpwood would not be a very profitable job. It was not clear why pulpwood in this country should be more expensive than elsewhere. The trees grew much better here than in any other country that was supplying on a large scale, so that the Swedes coming over here often wondered why, in spite of the fact that the wood grew two to four times faster than their own, the growers needed a very much higher price than growers in Sweden. It might be connected with capital cost of creating forests in this country or with the relatively small scale of operations. This was not for argument on this occasion but for consideration and working out whether it could be economic to have a pulp mill here. All the pulp-makers would say to the growers was, 'Make up your mind what you want us to do and we will make up our minds when we have collected the information necessary to gauge whether the scheme can be justified or not.'

Discussion

Mr. G. E. Edwards confined his remarks purely to hardboard and felt that the Sandwell Report had painted rather a glossy picture of its future from home-grown pulpwood. The report dismissed it by merely saying that the way to run a hardboard plant successfully was by integration, and by full use of wood waste.

This was a very ideal picture and in practice confined to Sweden and a few other parts of the Continent. It was not easy to achieve those ideal conditions in the United Kingdom, but the hardboard market was a very vast one and despite the rapidly growing chipboard demand was still the largest processed-wood market and one which was growing. Accordingly it was likely to be exposed to the greatest threat from the Outer Seven Scheme. In 1958 we imported about 450 million sq. ft. of hardboard compared with a home production of about 100 to 120 million sq. ft. and in the first seven months of 1959 imports were 303 million sq. ft. At the moment, unlike pulp, the board industries had a protective duty of 20 per cent. Their industry had the greatest difficulty in competing with imports —a difficulty he attributed to the cost of their raw material. In hardboard the main cost was in the wood as no resins or glues were required. Under the Outer Seven Scheme they were faced with a price cut of 20 per cent.—spaced over a period of ten years—at a time when it was difficult to compete. Cheap raw material was therefore essential, and that fact would have to be faced. Here he thought that there was scope for co-operation of the interested parties so that there might be greater integration in the use of the material, thus assuring maximum utilization of thinnings. The different industries required different specifications. Already they had found that working in co-operation with Sudbrook they could exchange some of their raw material. If they could aim at getting 100 per cent. utilization this would be a big step forward in cost reduction. All hardboard manufacturers did not have quite the same specifications—theirs were fairly wide from 2-inch-top to 10-inch-butt. Their machines could take 12-inch butts, but from experience their suppliers tended to go beyond the strict specification. They took all species and asked that they be clean cut and reasonably straight. They did not take cankerous logs and there was a limit on lengths. There was thus a fairly wide specification and the industry could assist greatly in the integrated use of various products. Use of sawmill waste was a thing of the future and this was probably a question of proper machinery. Species of course could be mixed and they were not at all discriminating although at present they were using 80 to 90 per cent. of Scots pine. They did not debark, as suggested in the Sandwell Report, and this again widened the specification. He felt that the board industries were essential to the country and to growers as they helped to find a regular market for thinnings. If there were no outlet for the thinnings the final crop would also suffer. It was true to say that manufacturers of board and pulp had spent much time and money to bring their plants up to date. This was necessary if they were going to compete with the vast number of new plants in Scandinavia and West Germany. They did not want to be too gloomy, however, about the intensive competition in the home market, but they must ensure that their raw material was obtained at an economical price.

Dr. Frankel, in reply to a question by Mr. Grayson, defined what he meant by 'economical' production of forestry products: not ring width, not percentage summer wood, not the volume measured by size, or solid volume. One thing only was required: bone-dry weight, bark free, per acre per year. The more the producers grew wood in a shape that was usable, the more economical the product

would be. The only limitations on shape related to the handling in the forest, to transport and debarking. As far as they were concerned there were very wide limits. If one could grow from one species a higher bone-dry weight per acre than another, then that was the species the pulp-makers preferred. What Messrs. Rendle and Chalk had said had been of the greatest importance. It was important to those who understood those things and for the pulp-makers to see that they made the best use of what was grown. It was of great importance also for those who selected species for breeding and to those who understood the influence of heredity and quality, &c., but for the practical grower there was one basic piece of advice: grow dry weight and not quality. On being questioned by Mr. Edlin, Dr. Frankel said they did not like larch. Far too much had been grown in his view because it did not give the maximum dry weight per acre per year, but as they had grown much larch he thought it was up to the pulp mills to use it, and when Mr. Pearson asked if there was any difference between Japanese larch and European larch Dr. Frankel stressed that all larch had a very high content of soluble matter which was troublesome. He thoroughly agreed with Mr. Hollingsworth that the existence of a market which was not as 'choosey' as the pit-prop market would help to maintain the specifications for which the National Coal Board paid such a high price. On being pressed by Mr. Cooper, Dr. Frankel repeated that they should grow what produced the highest dry weight per acre per year. The paper-makers would always import into this country an overwhelming part of their fibre requirements and they had the whole world waiting for their orders. They could thus select the fibres and mix them economically. This was the basis of their existence as paper-makers in this country. Most pulp-makers had not worried about the fibre characteristics of their wood. An ordinary pulp mill was built to take wood from the forest areas that surrounded it and therefore it was bound to certain qualities and species. If it had a sufficient knowledge it could choose the quality of the paper which was ideally possible from the available raw material. The paper-makers in this country had one big advantage—the advantage of not having forests. They simply chose the pulp they wanted from Canada, U.S.A., or Sweden. It was their job to know what to select. Therefore, whatever the growers produce economically could be used as part of a blend.

Mr. Hiley referred to the refreshing viewpoint of Dr. Frankel and to the fact that he had stressed the importance of economics. It was clearly our duty to grow timber and pulpwood as cheaply as possible. The Sandwell Report had assumed a 20 per cent. interest on capital, yet as foresters they would have been delighted if they could get 5 per cent., and that was one of the reasons why they wanted to sell thinnings at as high a price as possible.

Dr. Frankel disagreed with the Sandwell estimate of profit. Nobody, he said, expects 20 per cent., but he was not sure what the right figure should be. The amount had to cover interest on capital, pay dividends, and taxes, &c. One could look at the economic and financial aspects of the problem in two different ways. The financier would want to know the operating costs and the profit in relation to the market price of the pulp. One could not build a mill which took 5 years to build and then had a prospective life of 50 or 100 years, merely on the basis of

temporary fluctuations. What mattered to him was the cost. This was the basic element. If a pulp mill in this country was 'in the same boat' as a ground pulp mill in Sweden, then the mill would continue to exist and be an asset, because that industry was efficient and was the backbone of Sweden's economy. If our costs here were high, then we were on the wrong lines. To him it seemed essential to have a long-term link between the industry and the forest and it would not be right to base the estimate for a pulp mill on the prevailing wood price in Sweden, as it happened to be the lowest since 1938. If the wood price changed then the pulp price would change. At Sudbrook they had a few long-term contracts based on a formula under which the wood price varied with the prices of imported wood pulp. As a pulp-maker he hoped that the price of pulp would go up. A link was essential to give the forest part of the industry a share of the improved situation when the market price for pulp rose, and he hoped that something of the sort would be worked out in due course. Mr. Rankin pointed out that the Sandwell Report had referred to net profit as around 12½ per cent. and he suggested that this was probably the current level.

Mr. Rendle made another attempt to 'pin down' Dr. Frankel over the preference of pulp mills for different kinds of timber. Supposing that each of four or five working plans could give the same yield in terms of bone-dry wood, he asked Dr. Frankel which species to grow; what length of fibre; whether long rotations with little juvenile wood, or short rotations mainly of juvenile wood and springwood predominating, or thick-walled summer wood predominating? Dr. Frankel, answering not as a pulp-maker but as a paper-maker, said he would look for fibre supplies where he could buy them most economically and here he would be guided by the market price and the cost in those countries producing for the pulp industry. Short fibres could be purchased more cheaply than long fibres for pulp, therefore he would advise growing long fibres, and they would then import cheap pulp such as Eucalyptus. They wanted thin-walled fibres because the thick fibres were available from southern U.S.A. and countries which grew Maritime and other fast-growing pines. The price, for example, in the south part of U.S.A. would astonish producers in this country, the price per cord delivered to the pulp mill being about $18, which, converted into bone-dry fibre, would be about £5. 10*s*. per ton. This was the basis of the new industry in the southern part of U.S.A., where these pines, with plenty of summer wood, and also very wide rings, grew, and where pulp mills about five to ten times the size of those discussed were being built. He was no longer completely convinced that a new pulp mill had to be based on Swedish pulpwood prices, for these were at a much higher level.

Mr. McNeill asked for an explanation of the preference for long fibre. Dr. Frankel replied that part of the explanation could be attributed to historical and traditional views. The paper industry had developed here from the use of rags with very long threads, and these had accordingly been shortened in the pulping process. In 1937 or 1938 the Swedes started to send birch pulp to this country and the paper-makers were horrified because of its short fibre. After the war the Swedes were terribly short of softwood and they started to market the birch on a large scale, and by that time paper-makers were so short of fibre that

they had to take it. It was quite amazing what one could do when there was no choice. It took a long time, but then it was an industry which was not yet scientifically based. It was governed largely by tradition and what was thought to be right—but it might be very wrong, as the experience with birch had proved; we have now learned to use birch in spite of its short fibre. In England these short fibres formed much better paper when used in a mixture with long fibres, according to the grade of paper required. They had found that this was the ideal and they had succeeded at Sudbrook by mixing their hardwood pulp with imported softwood pulp. Those on the paper-making side thought that there was no actual advantage in using only long fibres, although this was only true for certain grades. The strongest paper made in this country required up to 85 per cent. of long fibres, but there were many other grades of paper containing say 30 to 40 per cent. of hardwood pulp. Although they had experimented with different proportions, they were never quite happy with more than 50 per cent.

In reply to a question by Mr. Harker about the need for using log ponds, Mr. G. E. Edwards said that he would prefer green timber for debarking, and that the less storage the better it would be for all concerned. In fact, one hour's storage of supplies would be ample if it could be guaranteed. Log ponds were used in Scandinavia because of stoppage of supplies in winter. Dr. Frankel agreed that storage was useful on the technical side but it implied a great addition to the cost of the mill; he did not know of any mill which would prefer to store its wood. At Sudbrook they did it because they were afraid of irregularity of supplies in winter, but they knew this was costly because handling charges were increased and the quality was reduced. They had only recently been discussing an alternative scheme of reducing the storage quantity and they were hopeful of concocting a scheme which would interest Mr. Ryle; so the pulp mill did not want ponds, either on economic or technical grounds. Pulp mills had to operate on a very narrow margin and had to be careful what they did. They used the bark for a considerable part of their heat supply and any wetting would destroy its value as fuel. Mr. Edwards, however, pointed out that the question of wet bark illustrated a difference in requirement between the pulp and the chipboard manufacturer—the latter actually sprayed the timber before chipping it.

Mr. Colley asked about the rigid adherence to length in the specifications, and Dr. Frankel pointed out that this was governed by the size of the barking machinery, and they had to apply a specification which did not waste wood. When Sudbrook had been designed they had had endless discussions with the Forestry Commission, private owners, and merchants, and everyone advised them wrongly. It was said that it would not be possible to get anything above an 8-inch diameter in hardwoods because it had other outlets. The specifications for maximum diameter were never adhered to. If they had been designing again, larger diameters would have been catered for. Mr. Ryle argued that Dr. Frankel's barking machinery outlook was all wrong. He wanted a fairly large supply, and there was no harm in admitting that they were trying to meet that supply. However, if they had redesigned the barking machine, not only to take larger sizes but the crooked shapes as well, then the supplies would be quite safe for the next 25 years. If they

could have an easier specification it would be a great help, particularly for hardwoods. Dr. Frankel felt that the problem was too much for the engineers. If anyone designed a machine to cope with crooked wood it would certainly cover the whole of the European market. The machine which they had installed was the most efficient available at that time, and had been chosen after consultation and experiment in Sweden. At the time the order was placed there was only one experimental machine in existence but now there were hundreds of these machines all over the world. The extraction costs of the Forestry Commission would have to be reduced.

On the question of using high-pressure water jets for debarking it was thought that this was too expensive for small logs—although it was used on very straight large diameter wood in Canada. It required a pressure of about 1,000 lb. per sq. in.

About the suitability of Highland birch, Dr. Frankel said that it was often too crooked. A sulphate mill could deal with the barky stuff. If there were a pulp mill in the Highlands, he was sure that it would absorb whatever hardwoods grew in the area if it were of a shape that could be handled.

(*b*) THE DEVELOPMENT OF THE CHIPBOARD INDUSTRY

By F. C. LYNAM

MR. LYNAM criticized the Sandwell Board Mill Survey because it did not do justice to the possibilities for the development of wood chipboard manufacture in the United Kingdom. It did not make it clear that the rapid growth of this new industry was a major evolution for all those concerned with Forestry, and the Wood Products industry. Wood chipboard was certainly not intended to be a substitute for plywood, nor, for that matter, any other board material; it was now established in its own right, and is sought after by all those in the furniture, building, and allied industries, interested in a quality man-made material.

Possibly the most important conclusion of the survey was that the price of the timber needed to make the manufacture of wood chipboard economically attractive, in even a large plant, should be between £11 and £12 per ton of bone dry wood. Merulius, author of an article—'The Great Pulp Panacea'—in *The Timber Trades Journal*, when discussing the Pulp Mill Survey, and the price of 170*s.* per bone dry ton, indicated that the grower and contractor were bound to need at least another 1*s.* 1¾*d.* per cu. ft. The survey had gone part of the way to provide that extra amount. Bearing in mind the greater latitude that could now be given by the wood chipboard manufacturer to the timber supplier over species and forms of timber, the price of £11 to £12 per ton was not unreasonable.

World production of this man-made timber product is such that plywood and other board manufacturers are realizing that they must enter this new field, or be content to let wood chipboard take over many applications which had been

served previously by what was now a more expensive, and in many instances a less suitable, board product. The Sandwell Report said that significant markets existed for wood chipboard, but that the output of any new, large-scale mill would require that new markets would have to be found. Mr. Lynam felt that this was an unsatisfactory comment, bearing in mind that methods had been developed to manufacture wood chipboard so that it possessed the unique properties desired by the many wood-using industries whose demands were at present quite unsatisfied. Thus wood chipboard was in a specially privileged category among other board materials, and he expected markets to react accordingly.

The Sandwell Survey gave this country's wood chipboard consumption figures as 29,000 long tons per annum for 1956–7. The production capacity estimated by F.A.O. for 1957–8 was 50,000 long tons per annum, which was equivalent to Finnish, Italian, or Swiss production. It was considerably less than Belgian and Czechoslovakian production, about a quarter of the French, and one-ninth of the West German figures for the same period. We still had a long way to go, bearing in mind that our population was approximately the same as that of West Germany, but by 1960 we would be producing no more than a quarter of the West German total.

The wood chipboard industry of the United Kingdom was at a critical stage. It could be seen that there was great scope for development; progress had been relatively slow compared with that of West Germany, and now, with the imminent formation of the 'Outer Seven' Free Trade Area, we were faced with Scandinavian competition based upon forest areas many times greater than our own, and with populations very much smaller than ours. The United Kingdom would offer a natural, already pioneered market for the wood chipboard produced surplus to their requirements by the Scandinavians.

Some of the Scandinavian timber was slow-grown, and volume for volume produced 15 per cent. more bone-dry fibre than our native trees. In addition, the size of the forest areas in the Scandinavian countries almost certainly meant lower prices for standing timber for the consumer, and lower extraction costs. On the other hand, our carriage charges for the finished board were much smaller.

On the size of any wood chipboard project, the Sandwell Survey also concluded that only larger plants were economical to operate, since smaller units producing 30,000 sq. ft. of board per day would require timber at about one-third of present prices if the project was to be economically successful. The larger plant producing 60,000 sq. ft. per day would need about 20,000 H. ft. of timber per week to make the enterprise a success, and that amount of timber had to be available within fifty miles of the plant. That was possibly the first condition to be specified by the potential manufacturer when he was deciding upon the site for the board mill.

The survey also referred to wood resources, but it was of course necessary for the wood chipboard manufacturer to indicate very clearly what species of timber was required, and in what form it was desired for maximum manufacturing efficiency. Mr. Lynam emphasized that the manufacturing process today was so infinitely variable and adjustable that practically all species of wood could be used, and in practically any state (except advanced decay).

Although the majority of plants in operation today were utilizing softwood, there were some which successfully included in their production certain species of hardwood, for example beech, poplar, oak, or birch. In some cases these species were mixed with softwoods during the process, but it was known that beech was very suitable on its own. In West Germany, for instance, in 1956 the total production of board included 24 per cent. of hardwoods; in 1957 this figure had risen to 29 per cent., and in 1958 to 31 per cent., beech, birch, poplar, and some oak being used, in that order.

The timber used was also in various forms—thinnings, slabs, offcuts, and peeler cores. The question of choice or preference thus became chiefly a question of economics. If breaking strength of the board only was the criterion, and if the price of the timber was determined only by its volume, then no doubt much more hardwood would be used than at present.

This point was illustrated by a chart, taken from a German report, which showed clearly that volumetrically less timber of heavy type was required to achieve the same board strength. For example, to obtain 3,000 lb. per sq. in. modulus of rupture in bending, in a board made from spruce, 1¼ volumetric units of timber were required, whereas only one unit of beech was needed to produce a board of equal bending strength.

Perhaps it was easier to specify the desirable properties in timber rather than to name the species favoured by the wood chipboard manufacturer. This was very necessary since quite often one requirement contradicted or excluded the other, and the balance can be struck only by co-ordinating or by compromising. The first important property was timber density. Lighter density was preferred, mainly to facilitate compressibility in manufacture, but also because the user in general required the lightest possible finished board. This enabled him to machine the material readily without blunting his cutting tools.

Strength was a vital requirement, of course, but the aim of the contemporary manufacturer was not only to produce the wood chipboard possessing this quality, but also one having a fairly dense, uniform, and smooth surface. For this purpose wood must be used which was capable of plastic deformation under certain conditions of chip geometry, moisture, temperature, and pressure. The low-density wood required little pressure for the same result and enabled the wood chipboard manufacturer to produce a comparatively light board. This desirable low density was limited by two requirements which are both incompatible with the density factor. One was a clean-cut surface of the prepared wood chip, and the other was low glue absorbency by the chip surface. Such requirements ruled out timbers such as balsa (it was not suggested that British foresters had much of it to offer) and would even put poplar into the class of suspects, since in some unfavourable conditions poplar chips had rather rough, mushy, and absorbent surfaces.

It would seem perhaps to wood chipboard manufacturers that the rate of growth was highly important only in so far as it affected the density, a feature already mentioned. However, apart from this, we would expect to find in a slower grown timber a higher content of natural resin, which we believe was both

beneficial for the surface finish of the board, and might possibly permit some economy in synthetic resin consumption. For the same reason, coniferous timber, with larger amounts of summer wood, would be preferred to the deciduous trees. The length of fibre did not worry the wood chipboard manufacturer unduly, since he did not intend to break the timber down to individual fibres. However, he took great care not to cut across the grain when converting the roundwood slabs, offcuts, &c., into chips.

The question of mixing timbers in the manufacturing process might depend largely upon the question of acidity. In this it was important to maintain consistency, as the degree of acidity has a bearing upon the setting of the synthetic resin adhesive required to glue the wood chips together. Fortunately, practically all the wood grown in Britain complied with the acidity requirements with pH 4·5–5; poplar is 4·2–5·8 but the value for Parana pine, for example, was too high. If of course the pH in the growing tree was itself not consistent, then there was not much that could be done about it, and if the manufacturer decided to mix the timbers, then he must be careful to maintain compatibility.

Naturally straight timber was preferred because chipping machines became uneconomical if too much air space was included in the feed; furthermore, knots were to be avoided. However, a range of diameters from 3 to 12 inches would be accepted, together with slabs and offcuts, and even veneers. Thus generally a fairly wide range of wood material was likely to be acceptable. In fact a good wood chip could be cut from a variety of timber species and forms of timber. The manufacturing process could be adjusted to permit a wide field of selection.

In considering the question of moisture, Mr. Lynam said that taking the worst case, the wood chipboard manufacturer could spend a great deal of his money on water, much to the delight of the grower who was delivering green timber, and it was as well to appreciate that the vital factor to the wood chipboard manufacturer was the amount of bone-dry fibre present in the timber, whatever the manner in which it was purchased. He showed a chart illustrating what happened when the wood chipboard manufacturer purchased on a weight basis; he averaged 160–70 per cent. moisture content, with surges up to 200 per cent. When he purchased on a volume basis, then the figure averaged about 120 per cent. In practice he should cut the chips when the moisture content of the timber was between 60 and 80 per cent. of the dry weight. If the chipping operation was carried out when the moisture was at the higher level, then drying costs became prohibitive. The answer to this problem was of course to have adequate stocks of timber, and that was why the working capital required for wood chipboard manufacture might be greater than was apparent at first sight.

Mr Lynam said that he was trying to justify the recommendations of the Sandwell Survey, namely that if foresters could collaborate to supply timber in all the varieties and forms he had suggested, the figure of £11 to £12 per ton for the bone-dry fibre as an average price was not an impossible target. It might be said that the insulating board manufacturer could afford £12 to £13 per ton, but he did not think variety, whether of species or of form, would be the keynote of their acceptance, and in any case, when talking about wood chipboard, he was talking

of an industry that as yet was not fully developed and could in time proceed to utilize timber in all its forms.

Another chart shown illustrated the relationship between the tree length and the heap of bone-dry wood chips from it, and indicated that, taking the average measurement of moisture shown, for every ton of tree lengths 840 lb. of dry wood fibre could be obtained. To achieve the bone-dry price of £11 to £12 per ton meant buying on a weight basis, unpeeled, delivered lengths at 64*s.* 6*d.* per ton, and on a volume basis of 3*s.* 1½*d.* per H. ft. At first sight this might not appear to be practicable, but taking into account the acceptance of hardwoods, slabs, and offcuts, this price was attainable as an overall average.

The next problem for a really big manufacturer, not mentioned by the Sandwell Survey, was the method of measurement of the timber supplied. Weight on its own was unsatisfactory. The volume measurement, where crooked and unequal tree lengths were concerned, was not reliable, and therefore Mr. Lynam suggested that the best way was to purchase on a tonnage basis, at an agreed average of say 28 H. ft. to the ton, adjusting price retrospectively with reference to accurate measurements of moisture taken over a yearly period. A practical method of operating such a scheme might be that each supplier would have his tonnage recorded by weighbridge, and would receive credit if in fact the actual records for a year's supplies showed that the hoppus measure was greater than 28 to the ton.

Mr. Lynam in summing up thought that the wood chipboard industry would prefer, as an ideal, to use low-density timber like softwood, which planed well, was straight, was of medium diameter, say 3 to 12 inches, had no big or dry knots, and was of 60 to 80 per cent. moisture content relative to the dry weight, and, above all, was uniform in its properties. The desirability of uniformity could not be emphasized too highly. The manufacturing process became easier if timber species did not change and age and moisture content remained constant. However, he made it clear that although these ideal properties were sought, they would be waived if cost became prohibitive, as might well be the case. If this were so, the undesirable fluctuations would have to be accepted for the sake of economic success, and equipment installed to deal with the deformed and maladjusted material.

If, looking into the future, the grower wished to encourage this new industry, then Mr. Lynam felt he should go for a coniferous timber, of any species, which would provide volumetrically the biggest yield in a given locality. He should grow the timber as fast as possible, have the plantation sufficiently large so that the board mill could be sited within fifty miles, and adopt a clear felling policy. If the wood chipboard industry were encouraged, it could absorb at least 20,000,000 H. ft. of timber per annum.

Discussion

In opening the discussion Mr. Richards wanted to know Mr. Lynam's views about the prospects of the chipboard industry in this country. This industry, he believed, had its origins in the use of industrial waste, but led by Mr. Lynam's company had in recent years turned more to the use of roundwood. He had

appeared to be optimistic about the ability of the industry to use a wide range of raw materials, and he wondered, firstly, how far he could foresee the geographical locations in which development would take place. There might be development in the Midlands where there was considerable wood waste and less roundwood, or a site in more remote parts of the country where there would be less waste material and a greater preponderance of roundwood. Secondly, he wondered whether there was any disadvantage in using unbarked timber in the process.

Mr. Lynam agreed that the industry started using industrial waste. They could not continue to rely on this material. It appeared likely that the industry would have to rely on round timber slabs, off-cuts, &c. Although some bark could be used in the industry, it had the disadvantage of soaking up resin, and it would produce hard patches in the board, and would be bad for cutting tools. However, he thought a board could contain up to about 5 per cent. bark, and this meant that much of the crooked material could be cut to short lengths and put through special chipping machines without worrying much about peeling, in order to get economic production.

In the discussion which followed, the main themes were on technical aspects of the process; moisture content and the interpretation of the percentages of dry weight; price paid; use of wood waste; transport distances and costs; scale of production; the competitive power and quality of the home product; and the nature and uniformity of the raw material.

In reply to a question by Sir Richard Proby on using mixtures of hardwoods and softwoods, Mr. Lynam said that this was possible—provided the requirements about compatibility and acidity connected with the effect on the synthetic resin were observed. Otherwise he saw no difficulty, because the structure of the board could be arranged in a three-layer process, whereby the hardwoods could be channelled into the core of the board. The reason for this choice was that the softwoods gave a better 'compressibility', thus providing a higher density and smoother surfaces.

On the question of moisture content Mr. Lynam said that the figure of 170 per cent. of moisture referred to the freshly felled wood. (When buying green round timber at £3. 4*s*. 6*d*. per ton delivered by the grower, by the time the water was removed and it was chipped, it was worth £11. 10*s*. per ton.)

Mr. Rankin raised doubts about the chance of supplies continuing at the above prices, and while Mr. Lynam agreed with this, for round timber he felt that the Sandwell figure of £11–£12 was reasonable, bearing in mind what was happening in Scandinavia. If this industry were to continue, the only way he could see of getting to that price was to include other categories of raw material. With thinnings alone it was not likely, but with a combination of thinnings, hardwoods, thick slabs, and offcuts it could be done. Mr. Rankin had been told a few days previously that if the hardboard industry had a raw material supply of good quality thinnings only, and no industrial waste at all, the quality would be much higher and the industry could afford to pay the grower more. Mr. Lynam thought that the hardboard manufacturer was in probably a much more difficult position than the chipboard manufacturer, bearing in mind the threat of the Outer Seven. Even

with the tariff protection which they had had for a number of years they had had a very great competitive struggle. Mr. Richards pointed out that although waste was the chief material in the Scandinavian hardboard industry, it was actually a pretty uniform material. Mr. Begley confirmed this, pointing out that United Kingdom waste wood would by contrast be a very mixed material. He found it difficult to believe that hardboard quality could go up if the industry used only wood waste.

Mr. Lynam said categorically that unless they got thinnings, they would not be prepared to buy at all. They would, however, give a higher price for thinnings—a price which a grower would consider a fair one. However, one producer said that he did not consider the current rate a fair price.

Mr. C. Harris added that in South Africa the hardboard industry was much more particular than the chipboard industry.

Mr. McNeill asked whether or not we should aim at being competitive with the high and improving quality of certain European boards. If we were to aim at high quality we would have to rely more on industrial offcuts. Mr. Lynam felt that they could still produce the quality which was necessary for the industrial consumers and still use raw material which 5 years ago would have been thought unsuitable. Here the development of special equipment, made in Germany, had been useful. By starting with small pieces it was possible to select suitable material in a way which was not possible when using timber of large sizes which often contained inferior parts. This was a big advantage and the industry should use it to the full and allow the consumer, which might well be the furniture industry, to introduce it into his mass-production methods as a precision material. They would not have the same amount of waste, or storage space requirements, and would not need to provide the same cutting facilities as were necessary in the past.

Mr. Rendle asked about the importance of uniformity in the raw material, as Mr. Lynam had appeared to view with equanimity the using of a mixture of hardwoods and softwoods, but in reply Mr. Lynam emphasized that he had tried to explain that the ideal would be to have uniformity, though in fact this would be completely uneconomic as the grower would want much higher prices to supply it. Thus the manufacturer had to compromise extensively in order to try to produce the dry chips at £11½ per ton. Hardwoods could be put in the centre layer, and a very uniform board could be made if spruce alone were used for the surfaces. Compromises could be carried some way but he did not think one should go to the extreme of producing only a utility board. In reply to a question by Mr. Ryle, Mr. Lynam said that the industry would be very happy to use Japanese larch.

Sir Richard Proby raised a question about the probability of competition from behind the Iron Curtain. Some of the financial papers mentioned that much capital was being sunk in this kind of plant, and there was the ominous remark that it was mainly for export. However, Mr. Lynam took the view that the U.S.S.R. were extremely short of materials of this kind for housing, and were putting in many pilot plants to meet their own needs. Czechoslovakia and East Germany might export to this country but this was unlikely. The home manufacture had certain advantages, and for instance could go a long way to giving industry just

the size of panel it required. Also he could store against future requirements, whereas if too much reliance were placed on overseas supplies, production might frequently be stopped.

Mr. Pearson thought that 170 per cent. moisture content was high. However, Mr. Lynam said that it was based on the actual measurements taken (and there were results up to 200 per cent.). Mr. Hiley asked about the relative moisture content of different species, as he understood, for example, that it was high for Corsican pine. Mr. Lynam said that their experience was mainly with spruce but there were variations in Scots pine.

Mr. Begley mentioned that on the Forestry Commission's information, large variations in moisture content occurred from tree to tree, and with the position in the tree. Thus it would be possible to get unrepresentative results if tops only, or suppressed or young trees only, were being bought. In risking a forecast of the results of a current investigation he felt that on the whole the figure of 170 per cent. was rather high if related to representative crops of Sitka spruce aged between 20 and 40 years and to buying in bulk from a large area, taking in various classes of material.

The use of the term 'bone-dry' was queried by Dr. Wilson who preferred the term 'zero moisture'. He felt that the figure of 80 H. ft. given by Sandwell was too high for an average bone-dry ton, and quoted lower figures for most of the chief conifers, from the Forest Products Research Laboratory reports. The estimate in the Sandwell Report was thus misleading, and he felt that the grower should have about a 10 per cent. higher price than the one in the report. Dr. Wilson assumed 12 per cent. moisture content because it was not possible to go down to zero. Mr. Lynam agreed that 80 was too high, and Mr. Begley said he hoped to be able to give reliable figures in a matter of weeks for the seven main conifers grown in Scotland, starting from the moisture content of freshly felled timber. This very extensive experiment was carried out because they realized that the whole question was so important.

Mr. Lynam said that there would be no point in importing logs if they were merely as cheap as the home-grown material. They would have to be cheaper and he saw no possibility of this, but they were worried about imports of board from the same material made in Scandinavia. About the suitability of the home-grown raw material at the price, he thought that it was satisfactory, provided manufacturing techniques were kept flexible.

Mr. Harris asked about the possibility of having smaller manufacturing units in order to reduce the cost of the transport item which was admittedly a high proportion of the total, but Mr. Lynam was quite sure that the unit had to be really large. The cost of timber was just over 40 per cent. of the cost of production of the board. The only way to bring down the cost was to spread the overheads over a larger production, implying a big unit. If the growers could concentrate on a fast-growing timber over a sufficient area to keep the haulage within 50 miles, and adopt a clear felling policy, they would be very happy! Mr. Richards uttered a caution about defining what a 'reasonable' transport distance would be, as transport rates varied considerably and might be greatly reduced where there was the

possibility of having paying return loads: one had to look at the local conditions rather than to generalize. Mr. Pearson wanted to know why a 50-mile radius was regarded as the limit, as one rather aimed to get either one or two round trips per diem with the lorries, and he felt that 50 miles was a rather small radius for one load per day. Mr. Lynam mentioned that 50 miles was the average haul at the Annan factory, but he agreed that loading methods, &c., had still to be improved and developed.

Mr. MacGregor asked if Mr. Sandwell's reason for favouring southern England was because of the nearness of market for the board, and Mr. Lynam agreed that this was the most likely reason and mentioned that the factory at Annan sent most of its products to High Wycombe.

On the possibility of increasing the scale of chipboard mills the benefit of which would undoubtedly be passed on to the grower, Mr. Lynam stressed that limits on size were set by the speed of the 'curing cycle', and by the speed at which the material could be run through the presses. At the moment the curing speed could only be increased at the expense of the board quality. He mentioned that high frequency had been used in the pre-curing stage only, and in order to make the contribution of output significant it would be necessary to halve the curing time. The only way to reduce cost would thus be to reduce the curing cycle, i.e. by producing twice the amount of material for the same capital cost. It would then be possible to go beyond the Sandwell figure of 60,000 sq. ft. per day.

Asked about the direction in which chipboard would most readily compete with timber in the building field, the speaker said that it could be applied where large surfaces requiring uniform properties were concerned—it was not just a question of supplying board but of supplying large surface units. This was a big advantage to the builder who did not always have the craftsmen. It provided him with a fool-proof material which could be used for many household purposes including flooring. A material could also be produced which would enable him to get an A 1 certificate for fire resistance. Mr. Richards then asked if chipboard was more likely to be suitable for industrial rather than for house building, but the reply was that much of the furniture was likely to be 'built in' in housing and the material was very suitable for this purpose—for residences as well as for factories and offices.

Mr. Rankin suggested that if the capital costs estimated by Sandwell were shown to be too high, the grower could be offered a better price. Mr. Lynam agreed that the figure appeared to be high. On page 11 of the report he had noted that capital investment was of the order of £17,500 per daily ton for 20 tons, but if increased to 35 tons the investment would be about £11,000, or a total of about £1½ million.

Mr. McNeill asked about the competitive power of batten or blockboard, as these might at least do away with the need to break down wood into little chips. However, Mr. Lynam regarded it as an inferior product—it did not give the same surface, and it was more expensive. He was prepared to 'stick his neck out' and say that there would not be much blockboard in future. Neither did he give Mr. Harker any assurance that the material would not compete with coffin boards.

Mr. Lynam in an addendu.n said that the most important point in all this was price, and the industry must here have the help of the growers if it was going to develop. He realized of course that the grower must get something out of it, but if the industry was prepared to be as elastic as he had indicated, there should be room for the development of the figure which Sandwell had mentioned. He left his audience to figure out that what he had said was not unreasonable—and possibly what he had said might have been of some use.

In reviewing the discussion, the Chairman referred to the figures for capital investment, and said that they were possibly on the high side. The flexibility of the industry was a point which had been stressed, and was obviously one of considerable importance. The ability to take mixtures of species helped to cheapen delivery costs because it was difficult to get sufficient quantity in any area. Handling costs had to be watched, which brought us back to the question of cost and the price at which it could be delivered—to which had to be added some return to the producer. Economics would be covered later in the programme but he had felt that a little more might have been said about marketing; or perhaps not so much about marketing as about the prices which the board obtained in competition with the overseas supplies. If the builder were asked for a high price would he still continue to buy?

Mr. Lynam had asked for flexibility from the producer but there was a point beyond which he could not reduce his price. If this were reached the industry could only maintain its profits by selling at a higher price. Were there any prospects in this direction? Mr. Lynam did not think so, for the simple reason that the principal competitors would be the Scandinavian countries where the total population was less than one-third and the total forest area probably more than twenty times that of Britain. Thus once they started developing on a really large scale they were likely to cut our price. At present this price was protected by a duty and the Scandinavian countries could only come below that price if they were subsidized.

The explanation of Sandwell's use of 'apparent current selling prices', according to Mr. Lynam, was that he was here conveying the fact that he did not know what discount was being allowed to the distributors and thus to the final consumers, but these could be as high as 25 to 27½ per cent.

II. VIEWS OF TECHNOLOGISTS

(*a*) ANATOMICAL CRITERIA FOR INDUSTRIAL USE

By B. J. RENDLE

SPEAKING on 'The Anatomical Background', Mr. Rendle gave a brief account of how the growth and structure of wood were believed to affect its suitability for pulp. He gave a warning that any general statement about wood properties in relation to pulp quality was subject to qualification because so much depended on the way the wood was processed and on the end product that was being made. What was important for one process or product might be unimportant for another.

It was common knowledge that it was the anatomical structure of wood—its fibrous character—that made it so suitable for the manufacture of paper, but it was surprising how little attention, relatively speaking, had been given, until recently, by the paper-making industry to the basic anatomical characteristics of their raw material and to the possibility of controlling the quality of their products by studying the wood itself. The reason for this neglect of the study of wood anatomy and tree growth was twofold. Firstly, most pulp mills have had very little control over the nature or quality of their raw material. They have either imported it in the form of pulp or have drawn wood from the nearest forest area more or less as it comes. Secondly, the nature and quality of the final product—paper or board or whatever it might be—depended so much on the very complicated processing of the material that research in the industry had been mainly in the fields of physics and chemistry and engineering. Interest in the growth and structure of the wood had, however, been stimulated in recent years by the industry's greater dependence on plantations and second-growth managed forests and by the development of forestry techniques for improving trees and timber. Forest geneticists everywhere were trying to get the pulp industry to tell them exactly what they wanted so that they—the geneticists—could apply their skill to improving the quality of the raw material.

Although relatively little systematic research had been done on the subject, nevertheless certain general relations had been established between the structure of wood and the properties of paper. Just as everybody knew that it is the fibrous structure of wood that makes it so suitable for paper, so nearly everybody knew—or thought he knew—that the length of the wood fibres is the thing. But it was by no means so simple as that. The length of the fibres, within limits, was only one of a number of inter-related fibre characteristics that affected pulp quality, and it would be a mistake to attach too great a significance to this one feature. The average fibre length of wood from ordinary timber trees varied very roughly from round about 1 mm. in hardwoods to 3 or 4 mm. or more in softwoods. Thus fibre length was one of the major differences between hardwoods and softwoods, and it was accepted that it is because of their lower average fibre length

that papers made from hardwood are inferior in tearing strength. Fibre length was important mainly in the lower range, up to, say, 3 mm. or so. A neat little piece of research in Australia had shown that, as fibre length increases, certain strength properties of the finished paper, notably resistance to tearing (but also resistance to tensile stresses and folding), show a marked improvement up to a fibre length of 3 or 4 mm.; beyond that point increase in fibre length resulted in only slight further improvement. This explained why so much emphasis was laid on fibre length in countries where short-fibred hardwoods are a major source of pulpwood. Tearing strength was not everything but it was important for certain types of paper, and if you were largely dependent on hardwood supplies, quite small increases in average fibre length would improve the quality of the paper in that respect. This could be achieved by adding a proportion of softwood or other long-fibred pulp to the hardwood. Fibre length in itself was not so important where softwoods were the main source of pulpwood. Incidentally in some circumstances fibres might be too long; they tended to flocculate in the screening process, which was objectionable. However, it seemed that, on balance, long fibres were more desirable than short fibres.

It was necessary to refer to the well-known pattern of variation within the tree, particularly the progressive increase in cell-dimensions from the centre of the tree outwards. It was well known that the fibres in the first few annual rings are shorter—often considerably shorter—than in the wood formed in later years, also smaller in diameter, and the walls of the summer wood fibres not so thick. It was well known also that this central core of juvenile wood, as it is called, likewise small thinnings and tops consisting largely of 'juvenile wood', is inferior as material for pulp because of the shorter fibres, and there are other reasons also. It was obvious that a fairly considerable proportion of the material coming from our plantations would be juvenile wood, but the average fibre length of the pulp could be increased by the addition of sawmill waste in the shape of slabs and edgings. There was also a prospect of being able to improve the quality of the natural wood by selecting and propagating trees with fibres longer than average, particularly in the juvenile wood.

Going on to deal with other fibre characteristics, Mr. Rendle explained that when thin-walled fibres, like the spring wood fibres (tracheids) of a typical home-grown softwood, are pulped and made into paper they tended to collapse to form a flat ribbon-like structure, while the thick-walled summer wood type of fibre tended to retain its original form. Consequently, contrary to what might be expected, soft, low-density, thin-walled spring wood made a dense, hard, compact type of paper with high overall strength properties, notably high bursting strength and tensile strength but low tearing strength, while the harder, denser, thick-walled summer wood made a soft, bulky paper with a rough surface, with good tearing strength but relatively low bursting and tensile strengths. While thin-walled fibres were generally more desirable, a certain proportion of thick-walled fibres was useful if not essential (depending on the type of paper required) to give bulk and to increase tearing strength. Properties could be modified considerably by beating, but it was important to note this essential difference in structure

between spring wood and summer wood. In the field of softwoods, where, outside the juvenile core, fibre length was generally adequate, and fibre diameter did not vary much, cell-wall thickness was probably by far the most important fibre dimension. So far as hardwoods were concerned it had been shown that the ratio of the fibre-wall thickness to the internal diameter of the fibre was one of the most important characteristics determining the pulping quality of the wood. Admittedly, the relative importance of the various fibre characteristics depended on the type of paper being made and on the pulping process employed. For some kinds of paper, including the important group of kraft and bag papers, it was desirable to obtain a good combination of bursting and tearing strength. For certain other kinds of paper, where the nature of the surface was all-important, a leavening of hardwood fibres might be required.

When we knew the principal type or types of pulp likely to be made in this country we should be able, with the co-operation of the industry, to assess the relative value of our species and the practical significance of variation in fibre quality within the species and within the individual tree. We would probably find that for any particular pulping process and type of paper, all our softwoods can be used but some are more suitable than others. We would probably be told that a mixture of species is acceptable within certain limits. And we might find that only a limited percentage of juvenile core wood can be accepted. If the mixture that we were growing was a rather different mixture from the ideal specification we might hope that the mills would be able to meet us by modifying their pulping process a little.

When we knew more precisely what the pulp mills would like to have and what they were willing to accept, we could take this into account in our plans for improving our trees by selection and breeding and by forest management.

So far as the basic structure of the wood was concerned, Mr. Rendle thought there was unlikely to be any material difference between the technical requirements of wood for pulp and for timber as regards our principal softwoods. There might be one or two species, however, that were not acceptable for pulp, or acceptable only in small quantities, and considerations of that sort might influence foresters in their choice of species for planting.

(*b*) THE 'JUVENILE' PERIOD

By L. CHALK

DR. CHALK began by pointing out that the problem of 'juvenile wood' was often oversimplified, in particular by the assumption that it was a matter of age. There was some evidence that distance from the pith gave a better correlation with juvenile characteristics—a conclusion that would condone rapid growth. But neither age nor distance from the pith supplied the mechanism of the change. The two most important mechanisms appeared to be the pseudo-transverse

division of the cambial cells in the softwoods, and intrusive growth of the cells after being cut off from the cambium in the hardwoods. Division of the mother cells might also play a part in variation within the ring in softwoods.

Suggestions that the duration of the juvenile period might be more closely related to distance (through the number of cambial divisions) rather than number of rings from the pith were confirmed by the recent work of S. H. Inchbold Stevens on *Pinus caribaea* and by A. M. Loach on Grenadier apple grown on dwarfing and vigorous rootstocks. The *P. caribaea* results confirmed that the relative sizes in different trees at different stages remained constant, but only when plotted against distance. The apple experiment also gave better curves when plotted against distance, but suggested that in a hardwood extra vigour might result in greater elongation of the fibres (contrary to the usual rate of growth relation in softwoods). This was also borne out by experiments in progress on *Shorea* sp., which also suggested that the period of fibre elongation might continue longer than that of the cambial initial.

Discussion

Dr. Wilson expressed the opinion that the study of cambial activity was fundamental to knowledge of tree growth and the formation of wood in all its varieties and modifications; the cambium was an 'embryonic' or generative tissue of seemingly simple character but of amazingly complex potential; that a study of the existing herbaceous forms of the natural orders containing shrub and tree genera, i.e. those embodying xylem (wood), might well repay the effort, by throwing light on the great variety of wood structure occurring in trees, particularly the hardwoods. He suggested that the cambium method of secondary growth of wood had probably been 'invented' in many natural orders of plants independently, and at different times. He felt that it was too early to tackle breeding experiments on juvenile wood, its amount and character, as suggested by both speakers.

III. VIEWS OF COMPETITORS FOR THE RAW MATERIAL

(*a*) REQUIREMENTS FOR THE COAL-MINING INDUSTRY

By B. C. HOLLINGSWORTH

MR. HOLLINGSWORTH referred to some of the main competitors for the raw material as the 'old boys' among the customers, those using sawn and mining timber. He explained that because of the difference in the specifications required they were not rivals. Now, however, that there was the prospect of sawn wood being cut from the smaller sizes of logs there might be some small overlap in demand.

Whatever their own thoughts might be, they must not be surprised if the possible developments of the pulp industry aroused feelings of pleasurable anticipation among producers. It had so often been unfairly said that the National Coal Board had been too keen as buyers, and no doubt the emergence of a potential rival was a natural cause for speculation. Mr. Hollingsworth went on to examine the historical record of the N.C.B. as a purchaser of native timber and also the possible effects of a new large consumer appearing on the market.

Twenty-five per cent. of all mining timber was hardwood and all of it was home-grown; only 32 per cent. of the softwood mining timber was home-grown, and it was thus in this category that there was still room for expansion.

In a review of the recent history of home-grown mining timber, Mr. Hollingsworth mentioned that it had been estimated that in the immediate pre-war years little more than 10 per cent. of the mining timber used in this country was home-grown, but in 1943 no less than 600,000 standards, or 96 per cent. of mining timber bought in that year, came from British forests. This involved widespread clear felling and led to an immediate reaction after the war, partly from colliery people dissatisfied with the quality of native supplies and partly because a halt had to be called to the slaughter. When the coal mines were nationalized in 1947 the percentage of mining timber bought from native sources had fallen to 21 per cent., and it soon became evident that the new organization would have to consider what should be its own policy on the purchase of home-grown timber.

A year or two later, after the Timber Branch of the Board had been formed, that policy was announced. It was that the Board should use as much home-grown mining timber as possible, subject to price and quality being suitable, but without incurring any obligations to subsidize in any way the production, and retaining freedom to buy in the most attractive markets. Under this policy and over years of co-operation, as well as negotiation, with the timber trade and with the Forestry Commission, the Board's purchases of home-grown mining timber have risen steadily until in 1958 they represented 47 per cent. of the timber used by the pits.

In fact, compared with 1939 the N.C.B. has more than quadrupled the percentage of native timber used.

The Board's purchase of home-grown softwood props and sawn mining timber in 1958 was half the total intake of home-grown mining timber and it amounted to approximately 16 million H. ft. This quantity was not evenly divided among the different coalfields. The Scottish Division absorbed 8 million H. ft. and the South Wales coalfield 2½ million, leaving 3½ million H. ft. to be taken by the seven English divisions. Scotland, indeed, was now relying almost entirely on native timber for its supports, but it had to be remembered that Scottish producers had traditionally been more interested in pit-prop production than English producers, and of course their country had huge coniferous forests to exploit.

The remarkable increase in the intake of home-grown mining timber in recent years had not been achieved easily. The poor quality of some native timber supplied during the war created a prejudice against it among many miners and many mining engineers. That prejudice was gradually disappearing, but it still existed in certain areas. It had been and it could only be broken down in one way, viz. by improving the standard of the article through better seasoning and better manufacture. In that task the Board had had willing co-operation from the Forestry Commission, the landowners, and the timber trade, and that work still went on. It had been accelerated over the past two years by some centralization of buying under the Board's Timber Branch, and by the issue for all categories of mining timber of standard quality specifications which were now uniform over the whole country. There had been a marked improvement, and in pit-prop production the Forestry Commission in particular had set a good example in quality standards, though of course there were also many private producers who turned out an excellent article. The N.C.B. was still trying to improve quality, and was taking new steps to that end.

What would be the effect on this large consumer if a pulp industry were developed in this country? To answer this question it would be necessary to know how many mills were likely to be established, their size, their location, and, most important of all, their potential demand for raw material. At this exploratory stage we could not expect firm answers to these questions, but we could speculate about the future. It might be supposed, for instance, that any substantial and rival demand for raw material would to the same extent reduce the availabilities for the existing consumer, but we could not lightly assume this was the case. Even if—and it was a big 'if'—the price offered by the new consumer were as attractive as or more attractive than the price the old consumer could afford to pay, there were other factors to be considered. Firstly, the amount of raw material available was not static—the afforestation programme in future years would bring increasing quantities of thinnings upon the market, and there would be enough perhaps to satisfy a new demand as well as the old. Secondly, the kind of raw material required by the new consumer was not necessarily the same as that required by the old. The pulp and board industry might well absorb lower-grade roundwood than the Board's standard (for example with more bow) and take timber which was quite unsuitable for use as supports in the collieries. To that extent it might

even help both the coal industry and the producer, by providing an alternative outlet which would enable the producer to find a lucrative market for all his forest produce. This should reduce the producer's overall costs and eventually perhaps reduce the price to the coal industry—but perhaps some would regard this as misplaced optimism. Thirdly, differences in the location of the raw material in relation to the consumer: within limits, the pulp or board mill could go to the forest area, whereas the colliery site was fixed. It might therefore be possible for the pulp mills to absorb raw material which faced a long and expensive carriage cost to the coalfield. This would not only leave the nearer forest material to be absorbed by the collieries, but over all would reduce the total carriage charges of the remote producer who wished to supply both the pulp and coal industries. Fourthly, the future demand of the coal industry itself for the raw material would have to be considered. English collieries especially might still increase their usage of native softwood timber at the expense of imported timber if they were successful in establishing uniformly good standards of quality at reasonable prices. But the coal industry had entered on a difficult period; it was faced with the closure of many of the older collieries, collieries which were predominantly timber-users, and its consumption of timber was falling. Increasingly, modern mining methods called for the use of support materials other than timber. Softwood pit-props and, to a smaller extent, softwood crown-trees would be in smaller and smaller demand over the next ten years. This was not to say that the demand for home-grown softwood mining timber would fall. Provided the quality could be maintained and improved, it could continue to supplant the imported article, and usage could actually increase as had been happening. Yet, remembering the developments expected in the coal industry itself, the ceiling would not be so high as some had at one time hoped.

From all this, it would be realized that the N.C.B. would not regard the development of a thriving pulp or board industry as a disaster threatening its raw material supply and its support costs. For many years it has purchased foreign pit-props from countries which were themselves large users of small roundwood for pulpwood; in fact, the pit-prop element in their operations was very small compared with the large volume of timber required for pulp. In spite of this and of a growing demand for pulp, the Board had experienced little difficulty in buying economically. Indeed, looking at the future from a national standpoint, the coal industry should, and Mr. Hollingsworth was quite sure would, welcome any development which tended to help British afforestation and which would add to the prosperity and stability of the home-grown timber trade.

To sum up, the N.C.B. had followed a policy of purchasing home-grown mining timber, had greatly increased its consumption of native timber since 1947, and still had room for increased supplies of softwood raw material. Rising production from thinnings might well be able to meet the demands both of the pulp and the coal industries, and the arrival of a new market for the raw material would solve problems and confer benefits on all consumers as well as on producers.

(*b*) REQUIREMENTS FOR THE FURNITURE INDUSTRY

By J. P. PRITCHARD

MR. PRITCHARD pointed out that the Furniture Development Council (F.D.C.) had for some time considered that chipboard was a very important raw material for their industry but that there might be other good types of board available.

In June 1954, when supplying evidence to the Watson Committee on the Marketing of Woodland Produce, the F.D.C. stressed the urgent need for starting research into the production in Britain of a suitable chipboard for furniture. They had proposed that the work should be undertaken by the Forest Products Research Laboratory at Princes Risborough. As no action was taken at that time, considering the matter urgent, the F.D.C. diverted some of its slender resources to investigate the use of the raw materials, and in the work they had been supported by one or two chipboard manufacturers. The amount of money for this research was, however, ridiculously small.

Mr. Pritchard concerned himself with the supply and demand—and not with the technical—problems of the furniture industry. He took the risk at his own responsibility of making forecasts, based on very little information, of the industry's demand for chipboard material.

Mr. Klauditz in a paper given to the International Consultation on Insulation board, Hard board and Particle board, organized by the United Nations Food and Agriculture Organization in November 1957, said: 'It is the author's opinion both technically and economically that the possibilities of the particle board industry outstrip the potentialities of other wood-working industries because of its vast raw material basis, its mechanized low waste production, and the great potential uses of particle boards as relatively light, strong, high-quality, and low cost products.'

This statement was made by someone dealing with the particle board manufacture and markets in general, including the building industry as well as the furniture industry and other wood-using industries. The use of compound materials of this kind in the furniture industry, however, did not support a statement as sweeping as the one quoted, but nevertheless all the evidence gave the impression that these materials were becoming more acceptable in the furniture industry of this country.

The chipboard industry was new and few detailed statistical data had been published. This made it difficult to gauge precisely the penetration of the boards into the furniture industry and the prospects. However, it was possible to try to get a general view of chipboard development since production began just after the war, and to try to make some guesses about how the industry was accepting them and the likelihood of increased acceptance in the future.

Generally speaking, the factor most in favour of the use of chipboard for furniture was its relative cheapness compared with other materials of somewhat similar quality. It had certain advantages and disadvantages and needed to be used in a

different manner from previous similar materials. It was not just an ordinary substitute and had to be considered on its own merits.

The total supplies of wood chipboard or of particle boards were not adequately detailed in published statistics. There were no satisfactory definitions, and the terms chipboard, particle board, and compound board were used indiscriminately. Nevertheless it was possible to measure growth and production since the early 1950's in Great Britain and in western Europe. Klauditz estimated that for western Europe production in 1958 would be nearly three times that of 1956, and his estimate of 4·5 million tons for 1960 was about ten times as large as for 1956. In Great Britain, however, the increase in production since 1956 had not been so spectacular; in the two years 1956–8 it had increased by nearly one-half, but the 1959 production was expected to be only slightly higher than the 1958 level. This led to the supposition that slightly less than 40,000 tons would be produced in 1960.

Imports into Great Britain, however, had increased much more sharply. The Forestry Commission estimated that about 7,000 tons of particle board were imported in 1958 (at this time no other official figures were published for the imports of wood chipboard and other particle boards into the United Kingdom) but already in the first two months of 1959 2,000 tons were imported, suggesting that the total imports for that year might well be in the region of 12,000 to 15,000 tons. At a conservative estimate, imports in 1960 would be in the region of 20,000 tons and might rise as high as 25,000 tons. The importance of imported chipboard to United Kingdom users was therefore clear. In 1958 nearly a fifth of the board used was imported, by 1960 the proportion would rise to 25 per cent. This might reflect the increasing interest of the furniture industry in suitable materials of this kind and suggest that, at least in the first few years, a high proportion would come from abroad. Had research started in 1954, or earlier, into problems of making a suitable board from raw material in this country, imports might be far less and the use of home-grown raw material far higher.

Use in the Furniture Industry and Future Prospects

The only direct evidence concerning the proportion of total expenditure over a year in the furniture industry for the various timber materials was shown in the Census of Production, 1954. The unimportance of compound boards of all kinds in the industry was obvious a few years ago. The direct competitors—plywood and associated materials—amounted to 16 per cent. of total expenditure compared with 0·5 per cent. for compound boards and 8 per cent. for veneers and panelwood. The approximate quantity of chipboard and similar materials used in furniture in 1954 was 360 million sq. ft. Mr. Pritchard agreed with Mr. Lynam about chipboard not being comparable with plywood, but owing to lack of statistical information he had to make these general assumptions.

There were, of course, technical limitations to the use of chipboard in furniture construction and it was probably unlikely that any more than half of the various plywoods and panelwoods used would in fact suffer direct competition from compound material such as wood chipboard, and at first sight it might have been

considered probable that, with the various technical problems still to be overcome, chipboard in the next few years would not exceed, say, 10 per cent. of those conventional materials with which it did not compete, i.e. 10 per cent. of 180 million sq. ft.

But it should be borne in mind that the quantity of imported particle board had risen by a factor of 3 between 1957 and 1959, and it was quite possible that this source of supply was an indication of a coming far greater demand. Richell, in a paper given to the International Meeting already mentioned, said: 'Referring to supplies in this country, because of the deficiency of suitable raw material for flake boards to be used in furniture production, it can probably be anticipated that the British furniture industry, once it has been sold on particle board, will import considerable amounts from Germany, Switzerland, Scandinavia, etc.'

If this demand exists, as it might well do, the proportion of directly competing materials giving way to particle boards might not be 10 per cent. as first suggested, but more like 30–40 per cent.—a very considerable increase.

It was possible to estimate from the statistics the effect which any radical increase in the acceptability of chipboard would have if this took place in the furniture industry. If the absorption rate were only 10 per cent. of competing materials, the industry was likely to use about four times as much compound board as it used in 1954. If Richell was right, however, an increase of ten times the 1954 amount was more likely, or 50 million sq. ft. of a grade suitable for furniture—now only produced in small quantities in this country. Mr. Pritchard felt that this might be regarded as the real size of the potential market in the furniture industry, and if the chipboard manufacturers in Great Britain continued to improve their board and kept the price really competitive, the market for the material would be very considerable indeed.

Is Furniture an Expanding Market in Absolute Terms as well as in Competitive Terms?

No doubt the main expansion in the use of chipboard would come from making competitive inroads on more traditional materials for furniture. But the expanding market for furniture as a whole should not be forgotten. Over the past 6 or 7 years the industry had been in a state of what could be called 'progressive stability'. In other words it had been expanding at about the same rate as the gross national product, and if this were to continue all the estimates would have to be written up by about 3–4 per cent. when talking of 5 years from now. This, however, was a purely statistical projection from a period when government monetary policy had been such that industries depending a good deal on hire-purchase had suffered most. He believed, however, that the picture in 5 years' time might be very different. Intensified technical research, collective publicity, and the growing size of firms might make possible large-scale development.

If they wanted more business the growers of the raw material and the chipboard manufacturers might well consider contributing to a collective publicity scheme for furniture and encourage housewives to demand more furniture made with more chipboard. In any case the absolute size of the market was attractive

enough. In 1958 the market for cabinet furniture was worth about £45 million, of which 10 per cent. represented materials in direct competition with the best chipboards for each job. Thus the potential chipboard market could be considered as amounting to nearly £5 million per year rising as the expansion mentioned above developed (allowing for price rises) to slightly over £6 million, and this referred to cabinet furniture alone. There were, moreover, reasons for believing that this increase might be very much greater.

What we do not know. It was clear from this brief paper that certain extremely important questions remained unanswered. For example, although something was known about whether chipboards could be acceptable in their present form to furniture manufacturers, we did not in fact know how far they had been accepted, nor the actual depth of penetration of the idea of using this type of material. Nor was the estimate of possible acceptance in terms of quantity any more than guesswork. Linked with these questions, there were also the technical problems concerning the use of chipboard which required more research work.

There were several ways in which growers and chipboard manufacturers could help to raise the demand for their product—if they tried to! The furniture industry was progressive and expanding. Owing to the contraction of the number of firms and the increasing turnover of the industry, the size of firm was increasing, making possible greater expenditure on design and development.

Financial support for research in the following fields would undoubtedly 'pay off': first, to determine the extent to which chipboard was being used and what the possibilities were; secondly, research into the technical problems along the lines that they had started (including some useful work with Mr. Lynam's firm); thirdly, research into conversion and production problems.

Discussion

The competition of the coal-mining and furniture industries

Mr. Richards thought that Mr. Hollingsworth had painted a rosy picture of the National Coal Board offering very substantial prices for home-grown pit-props. Whilst it was quite true that the prices being offered by the N.C.B. were considerably higher than those discussed on the previous evening for chipboard material, it was equally true that the specification for pit-props was considerably higher. At least it was higher in the sense that the N.C.B. required this material to be cut into a large number of sizes with a considerably higher standard of preparation. In other words it cost the producer considerably more to prepare and deliver than chipboard material. He asked for Mr. Hollingsworth's views on the point and also those of the producers of both categories on relative costs of preparation of pit-props and chipboard material.

His second point was tied to the first: the Board required a very large number of sizes of pit-props, and he wondered if Mr. Hollingsworth would indicate if it might be possible to reduce the number of sizes of props as a form of rationalization. A colleague in France said that this had been done in some of the French mines. Another point was that whilst it was welcome news that instructions had

gone out to all the areas about the standard of pit-props for acceptance, the interpretation of these instructions undoubtedly differed according to the individual. This situation must obviously continue for some time. He hoped that they would have Mr. Hollingsworth's assurance that the instructions would be followed by action designed to ensure uniform application of the Board's standards.

Mr. Pritchard had said that the furniture industry was one of the most progressive in the country. He thought this could only be so in certain directions, because when he had recently been in a factory supplying materials to the furniture industry he had been horrified to find designers thinking up new forms of wood which were then drawn on paper and reproduced in artificial materials. He did not think that this was very progressive.

Three main points interested him: firstly, the need for research. One of the difficulties of the appeal which the furniture industry had made to the Watson Committee was that it had been felt that the pressing problems to be solved were not the fundamental ones but rather those of producing chipboard on a factory scale. Rightly or wrongly, it had been said that the contribution which could be made, for example by the Forest Products Research Laboratory, would not really help to solve the problems because what was possible on a laboratory scale might not be possible in factories; and that in any case the chipboard industry itself had most of the 'know how'.

Secondly, no mention had been made here of changes in the style of the furniture in current demand, and what effect this was likely to have on demand for chipboard and other materials used by the furniture industry. He understood that one reason why Western Germany was quickly off the mark in this development was that the acceptable style in that country was somewhat different from the English tradition of the lighter styles of furniture.

Lastly, the question of money being made available by the chipboard industry and by the producers of timber for publicity, while interesting, was difficult because it also arose in other industries. One might also be asked to support the idea of giving publicity for traditional type houses in which timber was also used, and thus one might get led into all kinds of ramifications.

Mr. Pritchard said in reply that, from his close but short experience of research in industry, research into production problems and use problems would undoubtedly have an effect. He could not say—not having done the research—what the effect was likely to be, but faith was necessary in that kind of thing. It was always the obvious answer with any official—although it did not happen with Mr. Richards—to say it was difficult. It *was* difficult. An expert should be asked to say how a thing could be done, not how it couldn't be done. He was glad, for example, that the N.R.D.C. had stepped in over the Hovercraft development, and hoped that the Forestry Commission would follow their example and have the courage to go forward and force some research through on those problems.

He did not think that the style of furniture would have much effect on the total quantities involved. It was necessary to have doors and panels, and if they

could not be obtained from chipboard, other kinds of materials could always be used. He did not think that Mr. Richards's legpull about the procedure in one firm out of 1,800 was a very good example; perhaps people preferred to have imitation crocodile leather or whatever it was.

In defending support for the furniture industry he said that wives would like to have more and better furniture at a cheaper price, and he thought that everyone agreed that it would be better to have the home scenes more pleasant and beautiful and cheaper, and for those reasons alone the proposal should be supported.

Mr. Hollingsworth implied that it was usual to start off on price questions. It was always thought that the N.C.B. did not pay enough, and, on the other hand, if a higher price were given that the right article was not necessarily produced. He agreed that the chipboard industry's specifications were easier to supply, but he pointed out that the difference in price was also very considerable. After all, they were buying in a competitive market.

Peeled props were paid at 5*s.* 4½*d.* per H. ft. delivered under national agreement, and 80 H. ft. (a ton) came to something like £21½; unpeeled props were paid (for 100 lineal feet) at 12½ per cent. less, and although not many were wanted some had to be bought and these were paid at just under £19; where unpeeled 'tonnage wood' was bought this was an easier specification than the ordinary prop market, and this had a reduced price of about £5. 17*s.* 6*d.* per ton. All these prices compared very favourably with those mentioned on the previous evening, and with those in the Sandwell Report. The N.C.B. would like to standardize its specifications and a Standardization Committee had been going into this. He had had some experience of experiments in standardization in Scotland where against tremendous opposition from the mines more progress had at one time been made on prop standardization than in the English Divisions, and he felt that this would gradually develop. Strangely enough, the last time this had been discussed with the trade they did not seem to know whether they wanted simplified specifications or not. If the number of sizes and specifications were reduced, it also reduced the opportunities for close exploitation of the timber. So there were two sides to this matter, and if there were too much standardization, there was a problem for the producer. Standardization existed in the N.C.B.'s stockyards, and when buying from abroad attempts were made to get special specifications for the individual coalfields concerned, but difficulties arose even in this field. Bundling was extending very rapidly: all 'lids' and some 'coverboards' would in future be bundled; and in some districts some of the imported small props were being bundled this way. With so many small home-grown merchants all over the country it was not easy to get bundled native props, although with a simple tool it was easy enough for 'lids'. The more exacting specifications were admitted, but they were paid for. In the future more standardization was being attempted.

The following topics were raised in the subsequent discussion: prices; the trend of future demand per head; the quality of imported mining timber and comparable prices; Scandinavian problems over preparation; advantages of

inspection for quality production; the advantages of a depot; handling and bundling methods; peeling and moisture content, and length of contracts.

On the question of price it was held by Mr. Lynam that the trade was responsible for much of the difficulty that existed today. It had been suggested that more of the timber-users should collaborate. When the chipboard factory had been started at Annan Mr. Lynam had gained the impression that the trade were charging the N.C.B. for the whole tree, and when the mill started they still wanted the same rate for the tops and the swept butts as the N.C.B. It was for that reason it had been argued that the chipboard industry could really be supported at much lower prices, and furthermore that the chipboard specifications were much easier. Mr. Lynam had been puzzled because Mr. Hollingsworth had said that the N.C.B. would increase their use of home-grown timber, and he wondered about the quality aspect. The Scandinavian timber had a higher quality judged on a 15 per cent. higher proportion of fibre content. This was an important point justifying the higher cost compared with home-grown material. He thought that Mr. Pritchard had been a little pessimistic in his estimate of requirements of the furniture industry, and he informed him that the Weybridge factory was then producing at the rate of 15 million sq. ft. per year, and the whole of this production could be sold to three furniture manufacturers in the London area.

On the comparison of quality of the home-grown and imported prop, Mr. Hollingsworth said that at the N.C.B. research station at Bretby an experiment had been run on the fibre strength, taking samples from several forest areas at home including Scotland and from the overseas countries. By and large, the imported prop did come out better in tests with pressure against the grain. There were, however, indications that if the home-grown props had been fully seasoned —which many of them were not—although they might not have been quite as good as the imported, most of them would have been up to the required standard for their size.

Answering a question by Mr. McNeill on the meaning of 'not too quickly grown' Mr. Hollingsworth said that the N.C.B. had never committed itself on what was meant by this term although it had been asked to do so during discussions by government working parties held in 1951 and 1953. This question was one of the main reasons why the investigation at the F.P.R.L. into the strength of home-grown pit-props was started. The extensive tests would be finished by the end of the year and the results were expected next year. These might enable conclusions to be drawn about rates of growth.

It was agreed by Mr. Hollingsworth (in answer to a question by the President) that within limits the imported material might not be inherently or mechanically better than the home-grown. The imported was usually better seasoned, and with less moisture the strength was increased. There were other factors such as a great deal of trouble with home merchants who did not keep out the kind of prop which was not included in the foreign specifications, and were including too many rejects. In places like Finland the N.C.B. had measurers and inspectors to see on their behalf that the right material was shipped. But the N.C.B. still got badly

manufactured home timber, with ends not cut at right angles, with too much 'bow', with imperfect peeling, and so on. These faults, combined with high moisture content, were those which made a prop unsuitable for underground use. The question of the proportion of unusable timber in the Scandinavian forests was raised by Mr. Harley, and Mr. Hollingsworth agreed that they had so many generations' more experience than we had, and that probably they did not have so many problems in eliminating unsuitable material. In the past year one or two of the larger producers of props had started inspectorates to eliminate deficiencies and they had good results in some cases at least.

Mr. Richards said that the implication of the research work at the F.P.R.L. was that the preparation of the material and its proper selection could be more important than its rate of growth as such, and it looked as though degree of seasoning and amount of bow, in particular, would have a greater influence on prop strength than rate of growth as such. He felt that that bore out the practice of the N.C.B. which had never in fact drawn up any specification about rates of growth.

Mr. Hollingsworth admitted that there had been varying standards of inspection at the different mines, but a special notification had just been prepared to go out to every colliery to indicate the way in which the storekeepers should check the various categories of mining timber. Training courses for storekeepers and practical demonstrations had also been started (the first in Durham in August 1959, and others were being started in Yorkshire). By these means it was hoped to get a more uniform standard of inspection at the pithead. The producer was told about the rejected material, and he could see it either to arrange a credit note or take it back. One producer (Mr. Harley) present mentioned that he had received a shock by having a whole load returned at his expense.

Mr. Harker, as utilization officer of the Forestry Commission in East Anglia, said that many props were produced there, and he extolled the clear advantages of a central depot, in an area where there were 50,000 acres within a 10-mile radius. Their experience of converting at the depot, rather than at roadside, convinced them that it was the best way. It put them at a big advantage compared with producers with scattered forests or in hilly country. In the flat country at Thetford a lorry could get within 2 chains of any tree. On the question of quality, they liked to think that at Brandon they had set a yardstick for pit-props. The major influence was seasoning: with pulp the ideal was to fell today and sell tomorrow, but pit-props should be sold 3 months later and to do this required some organization. There were probably some fifty different sizes of props whereas with pulpwood there were about three categories (tree-lengths; billets possibly in two sizes; and the random lengths). Species came into it only to a minor extent at the moment. Not only was the specification demanded by the N.C.B. higher but administratively it was much more difficult to supply than other consumers. He suggested that although long-term contracts were being made—getting on for 6 months—even for the day-to-day work, let alone for the forest management, this was not enough. The nationally agreed prices of pit-props had moved much in line with the softwood timber market (c.i.f. Baltic

redwood) and price movements were quoted in support of this contention. It was difficult to find out what imported props were costing the N.C.B. but he supposed that 9*s*. per cu. ft. was the sort of price being paid. Thus there was quite a difference from home-grown. Personal contact for sale of timbers to colliery might provide better service than stock control.

There was scope for improving efficiency of handling timber all the way through the timber industry. It might only make a difference of 2*d*. to 6*d*. per cu. ft. but such amounts would be significant when it was considered that stumpage values ranged from, say, 1*s*. to 4*s*. per cu. ft. It was particularly obvious that the timber should be handled in bundles, but in order to provide that method, assured markets were necessary because of the high capital investment. The N.C.B. did not appear to have taken advantage of the possibilities of bundling, and indeed a story had been told of the cutting open of bundles on arrival at collieries. The Board had to decide what they wanted and, for example, what numbers they wanted in each bundle, e.g. 25, 50, or 60.

The standardization to a few sizes was not particularly welcome, as at the depot there was scope for better and more economic conversion if there were a variety of sizes. Statistics from Brandon were quoted to show the reduction of output in lineal feet per hour when cutting for a variety of sizes of prop and when cutting for pulp.

With bundling it meant that each saw bench had to accumulate round it four or five bundles of separate sizes when cutting a diversity of lengths.

It was felt that the contracts with the N.C.B. were unsatisfactory because they were too short and contained loopholes.

Mr. Hollingsworth said that the Board were trying to develop longer contracts and there were already some prop contracts which ran for a year. The difficulty about the excellent props supplied from Brandon was that in the Midland collieries which they mainly supplied there were changes of seam thickness and the demand changed from one seam to another.

Later on, in discussing the advantages of the drier and seasoned prop, Mr. Hollingsworth agreed that there were advantages in having longer contracts—at present the lack of these provided the producer with the excuse that he had not time to season. In answer to a question on short-term buying in Scotland he said the N.C.B. hoped to do something about this in the next year or two, but Scotland was the only one of the nine Divisions of the Board where centralization of buying under a timber officer had not taken place, and most of the buying from suppliers by areas was understood to be on short-term contracts.

He had been puzzled about the price of 9*s*. per H. ft. which had been quoted for imported props. The deliveries from Finland and Russia for next year, by the time freight and other costs to colliery level had been paid, were unlikely to be dearer than the 5*s*. 4½*d*. figuring in the national agreement at present. At the present moment the imported props in stock might be a little dearer than 5*s*. 4½*d*. though certainly nothing like 9*s*., but they were not the same article as the home-grown.

Experiments on handling methods had been carried out during the past 2 years, about forty areas having tried out new methods of handling all kinds of stores

including timber at the pithead. Small portable cranes, fork lifts, and other machines had come more into use and had altered the problems of bundling. He agreed that there were problems involved with prop sizes when it came to telling producers what sizes and kind of bundle were required. Although it had developed rapidly, one had to have patience, but over the next year or so the N.C.B. should be able to guide producers who were prepared to bundle props. At the moment he would advise producers thinking of this practice to consult with the Timber Officers who made the contracts, and get a firm agreement about bundling in certain sizes.

'Stock Control' was an old problem, but a large organization could not be run very well without it, and it had to be the basis for ordering stores of any kind. The system would have to continue, but it was not thought that the trade would suffer from it to any extent.

In response to a question by Dr. Frankel as to why the N.C.B. was prepared to pay more for home-grown props at roadside than was paid in Finland, Mr. Hollingsworth said that he did not know what the props cost at the roadside in Finland although he felt that it must be considerably lower than the costs at the roadside in this country; the N.C.B. bought the finished prop f.o.b. and then did their own chartering.

When Mr. Ryle asked about the Board's attitude to partial or strip peeling, as is practised in Germany, Mr. Hollingsworth said that he had been told by the mining engineers that they preferred a well-peeled prop because it dried out quicker and was less liable to decay. Miners preferred a well-peeled prop—there had been some objections to the lids being sent down in wire or tape bundles as the wire and tape were said to be a danger in confined working space. Another aspect brought out in the discussion was that many miners believed that a dried prop gave warning of impending collapse by creaking, but it was not known how far there was any actual proof of this. The extent to which a prop picked up moisture after it got below the ground depended on the site; many of the Midland mines were very dry. It was agreed that one of the advantages of paying on a delivered, cubic or linear non-tonnage basis was that it encouraged the producer to season the props.

(*c*) REQUIREMENTS FOR HOUSING AND PACKING

By S. E. WILSON

DR. WILSON declared that the principal aim of forestry development in the United Kingdom in this century had been, and still was, the production of sawn softwoods to supplant the deals, battens, and boards (D.B.B.) imported from Europe and utilized for many purposes, mainly in building and packaging trades. Softwood imports had fallen off in the past twenty years in quantity and quality and also in average size, as they were being sawn from smaller trees

because the stock of large trees had steadily fallen in the timber-producing countries.

Softwood timber prices were now some six to seven times the pre-war levels while metals, concrete products, and other competing raw materials for structural purposes were only three to four times 1937 prices. Timber technology had made progress, but other technologies had made spectacular strides, so that timber was both outpriced and outmoded in many of its traditional fields. United Kingdom softwood consumption had dropped from 2¼ million standards in 1937 to 1½ million in 1958. Demand, as shown by price, was relatively low for the inferior grades of D.B.B., while prices for the good quality and large deals were very high and still rising; this price gap was likely to become more pronounced as uses for the inferior grades fell away still further with the development of cheaper and better alternative materials for both building and packaging.

The rise of board-making industries, in Europe particularly, by producing something usable and saleable out of inferior grades of softwood otherwise unwanted, had now spread to this country with beneficial effects on forest management. The stimulus to thinning operations in forests within economic reach of the chipboard factories was contrasted with the state of affairs 20 or more years ago when small thinnings were practically unsaleable and silviculture was at a standstill on many estates. By comparison, today's price to the grower had to be described as very good indeed. At the same time the standing value of inferior trees, contrasted with that ruling for sizeable and high-quality timber, was, and must stay, relatively low, if our chipboard and pulp mills were to make headway against foreign competition from countries with vast quantities of the raw materials on their hands.

Forest managers should seize this new and valuable opportunity to grow massive quantities of high-quality and high-value sawlog trees with all possible speed. This could be done by selling for delivery to the board and pulp mills all small and otherwise inferior polewood, and then by applying the money so obtained to greatly increased attention to growing high-grade sawlogs as quickly as possible from the remaining trees. The aim should be a final crop of clear boles 20 to 24 feet long with an average top diameter of 12 inches under bark, which meant a top diameter range of, say, 9 to 15 inches. Two radical improvements in treatment of a typical conifer stand appeared to be called for, viz. thinning as heavily as the crop would bear and pruning to 20–24 feet to limit the core to 4 inches diameter.

In these days of high wages—and with still higher wages to come—the cost of these operations had to be reduced to a minimum, which meant mechanization to the fullest extent. Row thinning in place of the costly 'drawn thread' methods widely used today, followed by machine pruning as soon as suitable equipment had been invented, was advocated. Unthrifty stands should be clear felled and replaced. There was scope here for extensive experiment.

One result of increased activity on the lines suggested would be a greater out-turn of board-mill material than had so far been reckoned; another would be the earlier yield of prime sawlogs and the associated shortening of the rotation period, i.e. the main objective.

Competition for the raw material would arise between sawmill and board-mill in the later pole stage and for the upper parts of the bigger stems. The difference in both use and stumpage value would assuredly depend on the log-grade as determined mainly by knottiness. Pruned stems smaller than the size mentioned for final stage would find a ready outlet in the sawmills for batten production as in Scandinavia. These would be wanted for building work, while the unpruned and knotty wood would fetch the lower price paid for chipboard material. The conclusion was that the effect on management of the competition for the raw material that was already locally evident could become profound and widespread, and entirely beneficent if forest managers adopted modern methods —the aim being the rapid production of good-sized, best-quality sawlogs.

Discussion

Mr. Begley observed that Dr. Wilson's opening remarks were in line with the discouraging tone of the other speakers, notably Dr. Frankel. However, brighter prospects were held out in the second part of Dr. Wilson's remarks, especially over the high prices for prime butts. He had to make some criticisms of his facts, and argued that cheap production of sawlogs and extensive use of pruning were incompatible; current stumpage prices were not as good as he, Dr. Wilson, had thought. The Watson Committee's Report had contrasted the increase in price paid for sawn timber to sawmills with stumpage rates paid to home growers. There was need for putting matters in perspective when talking of competition: the home-grown quantities expected in 1965 and 1975 were of a high order even if we considered thinnings under 6 inches quarter girth (1965—19 million H. ft., 1975—28 million H. ft.). Sawlog timber (large thinnings and clear felled) might be of the same order. These quantities should be contrasted with Mr. Pritchard's estimate of, say, 4 or 5 million H. ft. to meet the chipboard market, even if Mr. Lynam had thought that this was a conservative estimate.

It was contended by Mr. Hiley that it would be possible to grow large timber profitably where it grew fast, but it would be expensive to grow big trees of Scots pine although large trees of Douglas fir, Sitka spruce, and Corsican pine could probably be grown more cheaply. The only difficulty would be about the markets for that sort of timber. Dr. Wilson replied that little information existed on these timbers in marketable quantities. He did, however, forsee difficulties with big trees, particularly Douglas fir, and especially the second lengths which were bound to be knotty. He just could not think of a use for them. In most thicknesses any knot with diameter of more than half the face width made it fairly poor stuff. The uses for F.P.R.L. grade 3 timber were diminishing rapidly. Architects were getting more fussy about knots both in constructional timbers and in claddings where any sheet material job was better served by chipboard, &c. He did not think that there would be any increase in demand for sleepers and crossing timbers, rather a decline. If they were cut into greater lengths a slightly larger knot could be tolerated, as with big knots one had to have big timbers to have the requisite strength. The users of big-dimensional timbers in the solid for that reason did not appear to be well advised. Dr. Wilson said that in an average summer Corsican

pine was liable to suffer from blue stain, which nobody liked, and it was very difficult to convince any consumer that strength was unimpaired. Mr. Harker pointed out that blue stain was likely to be found in any softwood. The remedy lay in the handling of the timber, to get it moving quickly and either have it air-dried or kiln-dried. Ideally they should go in for seasonal felling and only fell pines in the winter. Mr. Penistan felt that it was extremely easily prevented by dipping immediately after sawing. Mr. Harker agreed that it was fairly easy to deal with the problem of blue stain provided there was sufficient bulk. Corsican pine was liked in New Zealand because it had a good deal of late wood in it. If it were of good grade it would be in good demand, particularly if kiln seasoned. However, it was necessary to have efficient sawmilling in England before they could go very much farther. Mr. Rendle said that he had heard that when properly seasoned, Corsican pine was comparable with Parana pine.

Dr. Wilson agreed that in the United Kingdom as elsewhere there were still many primitive sawmills. Given the opportunity and encouragement, however, the sawmill industry would use modern equipment. The sawmilling capacity of the country with the existing modern machinery was above requirements for the available quantity of wood, and some modern plants were not running full time. It was not wise to invest in sawmilling and processing plants in advance of supplies of sawlogs. The cost of handling small and inferior stuff was several times that of larger clean timber, and blue stain was a bigger problem with smaller stuff. Where there was ample timber then there was no difficulty about putting down a modern plant or getting the necessary capital. Mr. Penistan was of the opinion that Scandinavian sawmilling of small logs was more efficient than in Britain, but Dr. Wilson countered that they were doing it with machines designed and made in Britain. In the United Kingdom the sawmills matched the timber available and thus new mills could be installed in a few weeks whenever and wherever this was warranted by merchantable supplies of logs.

Mr. Keen asked for the specifications of the ideal tree and Dr. Wilson replied that 12 to 15 inches diameter breast height appeared to be the European optimum, and nothing longer than 22 to 24 feet was necessary.

Mr. Venables stressed the importance of sales and said that buyers often demanded a higher standard of appearance than was actually needed for the job. In this the buyers were often in the position of Dr. Frankel—they could buy from the whole world and thus they had a very wide choice available to them. There was a high degree of competition and the profit margins were often much less than the 5 per cent. previously mentioned.

Mr. Maxwell Macdonald put in a plea for silvicultural considerations and mentioned the climatic advantages for good growth at home. He had recently obtained 462 H. ft. per acre of thinnings from Sitka spruce at 21 years old—and nearly all of this would have been suitable for pulp and there were some sawlogs as well. This result should give confidence to plant and should help the Forestry Commission in its purchase of land. We had, however, to get away from the timid practice of light thinning.

IV. FOREST MANAGEMENT CONSIDERATIONS

FOREST MANAGEMENT IN RELATION TO THE PULP AND BOARD MILL INDUSTRIES IN GREAT BRITAIN

By G. B. RYLE

MR. RYLE referred to his initial reluctance to follow up the subject but agreed that the discussions of the last two days were perhaps a little bit less desolating than Sandwell—*but* he was still of the opinion that we should be justified in running our forests *primarily* for these industries only under certain exceptional circumstances.

(*a*) Where the forest and the mill were so close together that a very cheap 'hot logging' practice could be adopted to get the whole production into the mill hoppers at a highly competitive price. As the forest could not go to the mill for this purpose the mill had to come to the forest: and what a forest it must be!

(*b*) Where, for some rather uncommon reason, it might be undesirable or uneconomic to grow the ultimate main crop of the forest on to sawmill size or to some other more high-priced specification. Such a case might arise where the need for the forest was for purposes of soil stabilization or for the maintenance of a local population. Otherwise the question might have to be asked whether or not there was justification on purely economic grounds for managing such a forest at all. There would often be grave biological risks which were perhaps hardly relevant to this discussion.

To put it another way, his opinion was that in this country, where the forests are necessarily man-made, where both management and exploitation costs were largely governed by high labour charges, we could very seldom be justified in thinking of pulp and board-mill material as anything other than an outlet for our subsidiary products, unless of course the present price levels were substantially improved. That was where we had to begin thinking, because the subsidiary products, if for example the aim was to grow sawmill logs as the main product, might well amount to 70 per cent. by volume of the yield of the crop throughout its rotation.

At the Seventh Commonwealth Forestry Conference held in Australasia two years ago it was resolved (though of course the resolutions amount only to recommendations which the Forest Services of the various Commonwealth members can then put to their governments if they think fit) that the necessary silvicultural thinning of man-made forests—this largely related to forests of exotic conifers—should not be neglected merely because such work was unremunerative. Now that was a very noble resolution, but it did not release the members from doing their utmost, and then a bit more, to make their thinnings remunerative. It was not intended to be an easy bonus for the pulp or the board

manufacturer; nor, he would add, for the National Coal Board! In any case, that was how it was intended to interpret the resolution in this country. The policy of the Forestry Commission was to seek for and sell in the most profitable markets.

For the purpose of this paper it was necessary to be clear what was meant by forest management. This could be taken to cover the matters of growing the right trees for the industry, of growing them at the optimum rate to a suitable specification (and there was doubt whether in this industry it could be conceded that the customer was always right as to specification), and lastly, but certainly not least, of carrying out all the formative and the supply operations as efficiently as possible.

1. *The Right Trees for the Industry*

It was abundantly clear, despite what Dr. Frankel had *very nearly* admitted, that the spruces were the best trees for the pulp manufacturer, and on very large parts of Britain they were fortunately the highest if not almost the only reasonable bulk producers, either as bone-dry long tons or H. ft. In view of what other countries were doing with *Pinus radiata*, *P. elliottii*, *P. patula*, and other pines in the pulp industry, it was disappointing that Scots and Corsican pines were now being rejected as unsuitable for pulping in Britain, because these species must of necessity be our principal forest crops on our drier southern and eastern side of the country. Maybe that would sort itself out later on by concentrating pulp manufacture in the west and board mills in the east.

Hitherto much Japanese larch had been planted, and for pioneer purposes this must continue, even if on a much reduced scale; but the pulp manufacturer had no use for it and the board industry was not very keen either. Fortunately it was essentially a short-rotation tree and found a ready market for use underground. The day of European larch, other than on a small scale, was thought to be passing. On rate of production and commercial demand, both larches were becoming pretty unattractive investments.

It was certainly to be hoped that the pulp industry would not close its doors on Douglas fir, hemlock, and some of the silver firs, because they provided valuable timber in the larger sizes and outlets were wanted for the smaller thinnings. More information was required on the status of *Pinus contorta* in Britain.

Obviously if there was great selectivity in species by the pulp-maker, it would be difficult geographically to route all the spruces to one or two large mills from all parts of the country where good spruce could be grown, and to route all other species from elsewhere to board mills or to the collieries. There would be endless cross-traffic and wasted haulage. This was of course another argument in favour of integrated industry turning out a wide range of timber products. There appeared to be no future for hardwoods either for pulping or board-making once our existing low-grade areas had been exploited. Small supplies would continue to be available, but no more than could be admixed with a main production of softwoods. Hardwoods continued to be grown for *timber* but mostly in a matrix of conifers which would constitute the thinnings.

2. *Optimum Rate and Right Specification*

Taking first the majority of forests which would be managed primarily for producing something more valuable than pulp or chipping logs, but which would look to those two industries as a major outlet for thinnings, generally the object would be to grow sawmill logs of clean specification at a quick and even rate of growth. These main crop trees would be selected very early and all other thinnings would be conducted almost solely to benefit them. For the rest the thinning could largely be governed by sales. The very fact of early opening up to give full crown space for our main crop would let in light and encourage quicker growth of the co-dominants and some of the sub-dominants which would thus develop earlier to economic marketable size for the chip and pulp industries. Maybe even the more conservative foresters in acting on this principle would find themselves approaching closer to the Craib-Hiley party of the left, though probably not quite associating themselves with these two revolutionaries. This might be right because even if we looked ahead all the time to the main sawlog crop as our deposit bank reserve, we must expect to make a modest living on the current account and not to fritter it out of the petty cash box. If there was any difference at all between a crown thinning and just an ordinary heavy thinning perhaps that was a definition and the best way to stop the temptation to get rid of sub-dominants before they attained a lucrative size.

Before talking about the other class of forest which we might decide to grow *purely* as a pulpwood or board-mill crop, something had to be said about specifications. What was the minimum diameter log which could be used? Was the present limitation of 3½ inches top diameter imposed by some of our buyers really economic? It was cheaper to use thick logs but that resulted in abominable waste in the forest, waste which it would hardly pay to convert for some other industry and thereby complicate and add to the costs of logging. If a smaller diameter could be accepted, even at a lower over-all price, the volumetric economics could quickly be calculated. But of course the presence of a greater ratio of juvenile wood in the small top wood prevented a simple arithmetical exercise. If redesign of peeling machines and chipping or grinding machines could enable the whole tree down to a 2-inch top to be utilized, it would be of outstanding national importance. Should this prove feasible, then the pure pulp or board-mill forest would be planted at about a 6-foot spacing and would be clear-felled without any thinning at somewhere between 30 and 40 years of age according to the site class and species. This would involve cutting well before the attainment of the maximum mean annual increment but would give very economical maintenance and logging.

On the other hand, if it were necessary to have a 3½-inch or larger diameter he thought that it would be necessary to have at least one heavy thinning—a light one would hardly be lucrative—as soon as about a third to a half of the length of each tree was up to the minimum size. This would obviously add to the total exploitation costs very substantially; but there would be some, though not fully compensating, gain in the M.A.I. on a longer rotation. Such a thinning might

well be a very artificial one without going to the trouble of silvicultural selection. We should still be bedevilled by the problem of separate production and sales problems of a large quantity of undersize topwood; alternatively we might leave that to waste in the forest. Would the pulp industry pay for that waste by a compensating better price for their larger billets?

3. *Operational Efficiency*

It was often suggested that those of our forests which were situated on poor sites and which would therefore be slow to mature to sawlog size might well be grown purely for pulp or chiplog markets. That was an absolutely wrong conception. Their slowness of growth was generally most marked in youth: as they formed canopy and created a better forest soil condition, there was often a marked acceleration, so that if we cut early we were merely going to make use of the slow-growing stage. Again, even if growth continued to be rather slow, it was from such crops that we might often obtain the higher quality close-grained mill logs on a necessarily longer rotation.

The first stage of increasing our production efficiency had therefore to be to shorten the period of slow growth on the poorer sites. Much work had been carried out on this aspect, both by soil cultivation and by application of fertilizers. We were even advancing now to older crops in an endeavour to secure more rapid growth on poor sites right up to maturity, by repeated fertilizer dressings.

It was in the exploitation operations where, as Dr. Frankel had told us, there was certainly plenty of scope for improvement of efficiency. The planning and layout of forest roads as well as their construction called for the keenest collaboration between the forester and the engineer. The Forestry Commission's work study teams had been largely concentrating their investigations on the whole range of operations to find out how they could be cheapened, but even apart from that we had certainly advanced, during the last war and since, far beyond our German, Swiss, and French colleagues despite their years and years of experience.

But again, study here should not be limited to study between the stump of the felled tree and the delivery of the logs to the factory. Work in the forest must essentially be scattered and all mechanization must be confined to mobile equipment. If any stages of the work could be delayed till the trees get to the factory where they can then be put through large, more costly but more efficient fixed machines, there would undoubtedly be scope for reducing costs. This was particularly true of debarking, which at least one factory still expected to be done in the forest. This was considered to be completely unjustifiable as it was so obvious that it could be done more cheaply and more efficiently in the factory as the first operation before the billets travelled down into the chippers or grinders. Again was there economic scope in the factory for diameter grading of the billets, maybe sending different diameter ranges automatically into different peelers, chippers, or grinders?

Plenty of modern large sawmills graded their logs mechanically into diameter and length classes for automatic conveyance to different sawbenches. There was

scope for the forester and the manufacturer to get together to examine the whole range of movements, with the aim of finding out the cheapest over-all methods; this would benefit both and ensure the fullest possible utilization of the whole tree.

Discussion

In opening the discussion Mr. Ackers made an historical survey based on his own experience, and emphasized the complicated problems of the grower: many species, differences in rainfall, soil, &c., and many types of owner. He was keen on pruning, and believed in carting out as little as possible—especially moisture. He had grown up in a period when one thought in terms of world shortage. He had now less assurance about what he should plan. There had been many changes in recent years—a market for 2 or 3 million cu. ft. of prime oak for railways had been suddenly lost, and many coal-mines were now closing down. These changes made one think about the future more than previously, but he took an optimistic view. There was scope for the new industries, particularly chipboard, but as it would not be possible to send timber for pulp unless we had a very good system of return loads, he could not see pulp helping the growers much. Among the species he mentioned were birch and *Abies grandis*, which with a smaller rainfall give a bigger bulk than Sitka. He was very chary about heavy early thinning as he wanted to grow quality. In South Africa recently he found that the technologists were saying that they had to get back to quality, and Dr. Craib was also emphasizing quality. He was all for quality, and for growing the very best and largest timber that could be grown in a matrix, and there was nothing like really big European larch (now making good prices), ash, beech, sycamore, and oak. He would like to see on the good land the kind of forestry practised by Lord Bolton, who was growing European larch with sycamore on an extensive scale, making an early thinning of the sycamore. The new board industries should help softwoods as these provided a good bulk.

Mr. Budden said that 60 to 70 per cent. of tree volume was in small material. We had almost reached saturation in the big markets, and could not handle the increasingly vast bulk of the current thinnings. He wanted to know what Mr. Ryle intended doing with the thinnings, if they did not go to the pulp industry. He was surprised that Mr. Ryle had said that spruce was the only timber that the pulp industry would take, when Mr. Lynam and Mr. Edwards had referred to the wide choice acceptable. There was in the country one mill which demanded spruce exclusively, but the price they paid entitled them to insist on this choice. His company, however, made no exceptions, and their view was that the forester should plant the species which would give him the best returns on the site, and they would use it. Without being influenced in any way by the pulp industry, the major proportion of trees planted in Scotland had been spruce, Sitka and Norway. The limit of 3½ inches top diameter was set by the debarking machines, and anyway smaller sizes were costly to handle. Mr. Ryle had said that the days of the small hardwood thinnings were over, but the conifer matrix thinnings from hardwood areas would add to the problem of marketing the softwood thinnings.

How did he aim to dispose of them if he did not support the development of large-scale markets such as the pulp and board industries?

Mr. Ryle said that Mr. Budden had misunderstood his paper. He, Mr. Ryle, had in no way implied that pulp mills were not going to be of enormous importance for consuming *thinnings*. He thought that the growing of forests for the *main crop* utilization as pulpwood was likely to be quite exceptional.

In the discussion which followed, the main themes which emerged were: the special requirements of the several pulp processes; the need for continuity of supplies for the pulping industry; economic aspects of thinning; effect of wide spacing on quality and species specifications; consumer preferences; comparison of imported and home-grown quality difficulties in marketing lower grades of sawn softwood and the potentially large agricultural market for small timber; and research and development projects.

Mr. Pearson referred to the variable behaviour of Sitka and Tsuga on quality class V sites: some had gone into check early but had developed quickly later on, and in others growth had remained very slow. Some of it suffered from drought crack, and would only be fit for pulpwood.

Dr. Frankel pointed out that mechanical grinding, as adopted by Bowaters at Sittingbourne and at Ellesmere Port, required spruce and a very high grade of preparation; the sulphite process—which was not used on any scale in this country but was of great importance in Scandinavia and to a less extent in America—also required spruce, and was almost as exacting in its preparation, but it could deal with wider and more varied size specifications; the sulphate process—which had developed more recently (in America on a large scale and in Scandinavia on a smaller scale)—could deal with all species and shapes available here.

When referring to the possibility of a new mill in Scotland, only the third process could be contemplated. He was greatly disturbed that Mr. Ryle could not see any future in growing hardwoods for pulping, especially as the invitation for the Sudbrook project had come from the Forestry Commission, and he did not think that the Forestry Commission had the right to take that view. It would be a great discouragement to pulp mills if the growers did not take any further interest in meeting their requirements, particularly after special machinery had been installed to deal with the class of material they proposed to deliver.

He did not altogether agree with Mr. Budden about the form of the pulpwood supplies. They had doubts about the quality of the top wood, bark per cent., &c., but he rather took the view that if the growers said it was economically necessary for their economy to find a market for their wood under 3½ inches diameter, then they had to explore the possibility of getting machines that could handle these sizes; he thought it would be possible. There were a number of Scandinavians who said that it did not pay to deal with such small material but many others used the tops of trees and said that it did pay. He did agree with Mr. Ryle that all the work that might be done in the pulp mill should be done there and not in the forest.

Mr. Harris took a more optimistic view than Mr. Ryle about the future of hardwood supplies for pulp mills. He had experience of planting trees on wide

spacing in South Africa, but there were not soils in Britain which would grow trees at very wide spacing. Mr. Gill urged planting at 12-foot spacing or about 300 per acre, and suppressing the weeds around the trees with polythene or heavy paper. Pruning could then be done in stages. It was a myth that close spacing could provide clean timber, for although the branches might be killed, they were not removed in many species. He thought that we must prune and grow trees quickly in order to get an economical return. Mr. Gill added that if wide spacing were to be adopted, it was necessary to have genetically suitable trees in view of the reduced number from which selection would have to be made. He also asked why the chipping should not be done in the woods.

Mr. Penistan drew attention to the fact that wide spacing was not a new idea (and mentioned Michie's book on *The Larch* (1883)). He mentioned that in Scotland large logs and mining timber sold quite well, but they were worried because there they produced more pitwood than they could use and they could not persuade England to take more. They were thus faced with finding an alternative use for small wood. It appeared as if the most hopeful outlets might be found in sawmilling and boxwood trades, since these required relatively little capital and might be in a better position to give a good price whether the logs were of top specification or not. We could still help ourselves before turning over exclusively to chipboard by watching specifications. In South Africa great attention was paid to this when timber was sold standing. He would prefer us to produce as big a quantity of saw-timber as we could, and do this by applying crown thinning, and without pruning too many trees. Some system of poles with standards might be a very satisfactory method of management on suitable land. On poor sites the tops, and often the bark, were better left in the woods as they helped to maintain the nutrient supply.

Mr. MacGregor, in support of the idea that the management should provide what the consumer wanted, quoted the views of the pulpwood buyer of Bowaters (Mr. Camburn in *Timber Trades Journal*, 16 May 1959) who had emphasized that he preferred clear-felled timber. Some of the timber which had been prepared in the early days had had too much moisture, was not evenly tapered, and not always completely round in cross-section. Smaller-diameter logs were found to be weaker than the imported, and had lower density and higher moisture content. They had also found too many knots and bad pruning, and he implied that more care should have been taken to inspect them at loading. The lengths supplied required attention to obtain maximum economies. Bowaters had experimented with pines but now excluded them.

Mr. Maxwell Macdonald said that the criticisms made by Mr. Camburn for Bowaters were of the type which could be called teething troubles, and the growers had not understood what was wanted. If Dr. Frankel did come with his pulp mill to Scotland they would make a big effort to give him what he wanted.

Mr. Hiley had learnt from Dr. Craib that in a South African project, which Courtaulds were working, they had already planted 80,000 acres in 6 years. It was now all going to pulp. Planted at 9 by 9 feet, no thinning or pruning was undertaken although brashing was done up to 8 feet high for fire protection.

Dr. Wilson pointed out that the main supply of wood for boxes was imported as 'shooks'. The trade had received a severe blow when Messrs. Beaver Bros.—the principal users of these boards for food products—decided to use cartons instead of wood. One of the main difficulties for the home producer was that the imported stuff of similar size was better quality for boxes and moreover the timber from Finland could be delivered to the south of England cheaper than that from Scotland. The timber importers were also very efficient at distribution.

The Chairman said that in New Zealand the biggest wood utilization unit was based entirely on plantations of exotics, and while the sawmill department made a loss, this was more than made up by the pulp mill. This was mainly due to difficulties of marketing, but the timber was knotty as the plantations had received no attention. It did, however, illustrate the difficulty of marketing these lower grades of sawn material. He also mentioned a very modern and large wood-using plant in Brazil which used all the four main pulping processes, and the first thinnings of Parana pine were used in at least one of them, the firm being very conscious of the economic aspects of the thinning.

Mr. Ryle desired to know of any pulp mill in England, or any about to be built, which would take non-spruce timber. He did not want to overstress the importance of the timber excluded under 2 or 3½ inches diameter, since it was of small importance in the total volume. He would like to see the whole tree go, unconverted, into the mill. He still thought that the supplies of hardwood for Sudbrook would dry up in the present generation, i.e. within 25 years. He welcomed the pulp and board mills as we were beginning to want them more and more for consumption of thinnings. If economies were made on both sides perhaps we could agree over the prices. Mr. Harley mentioned that Bowaters' prices at Sittingbourne were lower for non-spruce species than for spruce.

Mr. Edwards emphasized that although they did not specify any species preference, they did get about 90 per cent. Scots pine because they were in a pine area. They had had one experience of Tsuga: it could not be chipped satisfactorily, and the bark was too wet and stringy. It was, however, pointed out that hemlock was used widely in West Canada with Douglas fir for paper-making, though inferior to spruce at least for some purposes.

Mr. Ackers referred to the very large farm market for stakes, as well as for housing schemes and gardens. Mr. Harker thought that the agricultural market had scarcely been touched. There was a great variety of thinnings which the small forest, in particular, could supply to the local agricultural needs rather than to the mono-markets of pulp and pit-props. Boxwood was almost a rude word in East Anglia—it was an uncertain market which rose and fell, the Cinderella of the timber trade. There was a big potential in the market gardening and fruit-growing trades, e.g. for non-returnable containers.

Mr. Harker also thought there was scope for extending the use of frame saws for handling thinnings from plantations. He disagreed with Mr. Ryle that all debarking should be done at the factory, because for pit-props it was important to peel them early so that they could be seasoning; and there was the view that bark should be left in the forest to return nutrients to the soil.

Mr. Penistan felt that the farm market for softwood was not necessarily for top grade but it might be better for certain areas of rural England remote from the ports and the pulp or board factories.

Mr. Richards mentioned that he was at present involved in research and development projects which State and private foresters said were necessary, and that together with colleagues at the Forest Products Research Laboratory there was quite a big programme under way. He expressed disappointment that no sooner had foresters outlined a problem and set a rather expensive machine in motion than they changed their ideas and were quite ready to abandon the industries which had been set up at their request. From his experience of consultation with those industries which had approached the Forestry Commission, he felt that the growers would have to give the industries more long-term confidence. There were people with capital who were interested in our forests. To secure their co-operation the growers would have to back up their words with deeds.

V. THE ECONOMIST'S EVALUATION

SMALL-SCALE PULPING IN THE UNITED KINGDOM

By G. W. TROUP

MR. TROUP did not pretend that he could give the final answers on the prospects for small-scale pulping in Britain, but hoped that he could suggest some of the questions that remained for investigation. In the first place, it had to be said that the Sandwell Report on its own was inconclusive. It was a very valuable study as far as it went, but its terms of reference were necessarily restricted—with the result that the analysis was of a static nature. Thus, the study failed to look into the broad economic environment of the European pulp and paper industries, and did not take account of such matters as possible cost and price trends in the future. It also ignored the implications of freer trade, which, at the time of the investigation, seemed to be a distinct possibility and which, as could then be seen, would be put into effect as a result of the Outer Seven Free Trade Association. The investigators were not to be blamed for this, but it was important that the shortcomings of the report should be recognized, and that attempts be made to fill in the gaps.

Mr. Troup first of all reviewed briefly the main conclusions of the Sandwell Report, and the apparent inferences of these conclusions for British forestry. Next, he thought that it was necessary to question the validity of some of the assumptions that were made by Sandwell; and, finally, he thought it would be useful, in order to obtain the right perspective, to look briefly at some of the current trends in European pulp and paper developments.

The principal methods and conclusions of the Sandwell Report seemed to be as follows. First, the authors selected three cases for examination: these were bleached sulphate pulp (not technically integrated with paper production); mechanical pulp, again non-integrated; and mechanical pulp, in this case integrated with paper production. In each case, estimates were made of capital cost, manufacturing cost, and gross earnings, assumptions being made as to the likely level of output prices. For each of the cases examined, estimates were made of costs and prospective returns at a productive capacity of about 17,000 tons per annum and a pulpwood price of 170*s.* per bone-dry long ton (B.D.L.T.)—which amounted to approximately 2*s.* 2*d.* per H. ft. Secondly, estimates were made for each of these cases operating at a lower capacity scale—about 10,000 tons per annum; and in this method the price of wood was treated as a residual item—i.e. the price that could be afforded by a mill, having regard to the estimated costs of other items, the estimated value of annual sales, and the need to obtain a satisfactory gross return on capital. Thirdly, a calculation was made for each grade to show the minimum scale at which production would be economically feasible, given a pulpwood price of 170*s.* per B.D.L.T. The results could be summed up as follows.

Firstly, at a capacity of 17,000 tons and a pulpwood price of 170*s*., the only case which seemed to qualify as feasible was the technically integrated production of mechanical pulp. This yielded a prospective gross return of 27½ per cent., as compared with 14 per cent. for bleached sulphate and 9½ per cent. for non-integrated mechanical.

Secondly, from the next kind of approach it appeared that at a capacity of 10,000 tons the prices that could be afforded for pulpwood were:

Bleached sulphate mill: 20*s*. per B.D.L.T. (about 3*d*. per H. ft.).
Non-integrated mechanical: Nil.
Integrated mechanical: 150*s*. per B.D.L.T. (about 1*s*. 11*d*. per H. ft.).

Thirdly, at a pulpwood price of 170*s*. per B.D.L.T. the minimum scale of operation to give the required gross returns on capital would be:

Bleached sulphate mill: 24,000 tons per annum.
Non-integrated mechanical: 60,000 tons per annum.
Integrated mechanical: 11,000 tons per annum.

In brief, it was concluded in the report that:

(*a*) Very small *non-integrated* groundwood mills were likely to be uneconomic (about 60,000 tons a year would be the minimum, assuming a price of 170*s*. per bone-dry long ton of pulpwood).
(*b*) Small *integrated* groundwood mills (about 11,000 tons) would be best established on the site of existing non-integrated paper sections (e.g. at Newcastle or Edinburgh). This, in fact, though giving restricted scope, was considered to be the best prospect for small-scale pulping in Britain.
(*c*) A small *non-integrated* bleached sulphate mill would require a minimum annual capacity of about 24,000 tons of pulp (170*s*. could be afforded per B.D.L.T. of pulpwood). This was considered to be the best non-integrated proposition.
(*d*) A small *unbleached* sulphate mill was thought to be a less attractive proposition. This case, however, was not examined in the report.
(*e*) The semi-chemical process was stated to be suitable only for indigenous hardwoods.

The most striking conclusion for British forest owners was that small-scale pulping seemed to be feasible in the United Kingdom only if pulpwood prices were reduced to approximately 170*s*. per B.D.L.T. This was about half of the then existing price, and somewhere in the region of Scandinavian and North American prices. It would certainly be objected by the forest owners that such a price level would be quite unreasonable and would involve them in losses. The questions at issue were, therefore:

(*a*) Could production and delivery costs for home-grown pulpwood be reduced to an extent that would imply reasonable profits on a price of something like 170*s*. per B.D.L.T.? and
(*b*) Was it possible to modify any of the Sandwell assumptions in such a way as to provide a more favourable outlook for pulpwood suppliers?

On the second question, the following factors might be looked at more closely:

(*a*) The question of a 20 per cent. gross return on capital, as stipulated by Sandwell, had already been referred to in the conference. Mr. Troup's view was that this was a reasonable objective, having regard to the cost of borrowing, high taxation, and the need to make provision for depreciation and replacement of assets.

(*b*) On the question of the likely yield of pulp from home-grown pulpwood, Sandwell used a conversion factor of 80 H. ft. per B.D.L.T. If further investigation showed the possibility of a higher yield, this could have a significant effect on the results.

(*c*) The prices that were assumed by Sandwell for pulp sales were £53. 10*s*. per ton for bleached sulphate and £29. 6*s*. for mechanical. These did not differ very greatly from the average of the then current import prices, and therefore the assumption seemed at first sight to be reasonable. On the other hand, it could be argued that as the demand in Europe for paper and board rose, and as Scandinavian timber resources became relatively more scarce, there might well be a rise in the prices of paper. Upon this argument it might be said that British pulp mills would be able to pay more for their wood than the 170*s*. per B.D.L.T. postulated by Sandwell. This kind of reasoning, on the face of it, had considerable relevance to the problem of future pulpwood prices. However, it could be stressed that home-grown pulpwood prices could be allowed to exceed Sandwell's 170*s*. only if Scandinavian pulp mills began to pay more for their wood.

Sandwell's pessimistic conclusions for pulpwood prices had to be accepted unless we found very strong reasons for amending his assumptions. It was certainly true to say that small-scale pulping would be right out of the question at the then relatively high level of pulpwood prices; these were much too high in comparison with domestic prices in Scandinavia.

It had to be remembered in this connexion that home-produced pulp and paper had to compete with imported products, which could be manufactured very cheaply in the large timber-growing areas of Scandinavia and North America. As a prospective user of home-grown wood, the British pulp industry was, therefore, much more open to foreign competition than, say, the coal-mining industry, which was then the main user of British coniferous thinnings. Moreover, in pulp production, wood constituted a very high proportion of total production costs. In this respect there was a big difference between the raw material problems of pulping and coal-mining, for in the latter case wood was a very small item in unit costs and, therefore, price considerations were relatively much less important. As suggested by Dr. Frankel, the problem for British pulp mills was not to secure home-grown wood at prices which compared favourably with those for imported wood, but to obtain home-grown wood at prices which did not differ significantly from the domestic prices actually paid by Scandinavian pulp mills.

Broadly speaking, a British pulp mill could not afford to pay more for its wood than was paid by the Scandinavian mills, except to the very limited extent that

the British producer might sometimes enjoy lower delivery costs to his customers. There was no tariff protection against pulp imports. Similarly, British paper-makers, producing by technically integrated process from home-grown wood, could not afford to pay more for their wood than was paid by the Scandinavians, except to the extent, firstly, of any freight advantages that might exist, and, secondly of tariff protection. But since, under the Outer Seven Agreement, duties on paper imports were to be eliminated over a maximum period of 10 years (the transitional period might turn out to be less than this), the second of these factors could be left out of account.

All of this might seem very disheartening from the British forestry point of view, but in fact, in the long term, the trend of demand in Britain and Europe generally for paper and paper products would generate a considerable expansion in the production of raw materials for pulping. Consumption of paper and board in western Europe might rise from the present 15 million tons to some 25 million tons by the early 1970's. This would probably mean a rise in the demand for pulpwood——from 50 million cu. m. to about 75 million cu. m.—after taking account of trends in the utilization of other fibres, such as straw, bagasse, and waste paper, and possible economies in the processing of raw materials.

This was the most rapidly expanding sector of the forest products industries, and one which had already caused pulpwood to rise to a proportion of 51 per cent. of the total industrial wood cut of the Scandinavian countries. The corresponding proportions for the whole of western Europe and for the United Kingdom were 30 per cent. and 5 per cent., respectively. Could British forestry take advantage of this situation? British consumption of paper and board was then roughly 4·3 million tons per annum, of which 3·3 million was home-produced and 1 million was imported. About 70 per cent. of the raw material for home-produced paper and board was imported, so that from a quantitative aspect there was no real limit to the potential demand for home-grown pulpwood.

Whether British forestry would move more towards the Scandinavian pattern of utilization was, as already suggested, largely a matter of relative costs of pulpwood, and trends in final paper prices. In spite of tariff reductions it seemed reasonable to suppose that paper prices would be maintained, and might even show a rising trend in the long term, associated with increases in Scandinavian costs of production. It seemed essential, however, if new British pulp mills were to be established, that the gap between Scandinavian and British pulpwood prices would have to be eliminated. This conclusion was quite inescapable, whatever the future trends of pulp and paper prices might be.

In view of all these difficulties, it might perhaps be concluded by British growers that domestic pulp industries were not worth bothering about; and indeed this sort of reaction might be quite understandable if sufficient alternative outlets existed for future coniferous thinnings. However, the fact of the matter seemed to be that if new pulp mills were not established in Britain over the next few years, there would be a very substantial and cumulative surplus of thinnings from the 1960's onwards. Forest owners would not have to rely too much upon disposing of their produce to the collieries; mining usage had a very uncertain

future, and even if home-grown wood replaced all imported pitwood there would still be a serious disposal problem in the absence of future pulp-mill developments.

This brought Mr. Troup back to his earlier question on the possibility of reducing the costs of production and delivery of home-grown pulpwood. It might be asked whether shorter rotations and clear-fellings specifically for pulpwood could provide the answer to this problem. These possibilities seemed to have been dismissed fairly summarily by some of the previous speakers, but the only alternatives might be a higher degree of subsidization of British forestry or simply a failure to sell the whole of the crop. It might be added, incidentally, that a higher degree of processing of home-produced wood, as in pulping, would be desirable from a national economic point of view. This was happening in Scandinavia, where there had been a relative switch from sawlog to pulpwood production.

Mr. Troup concluded by summing up what appeared to him to be some of the main features of the problem. It had to be admitted that the Sandwell Report was not encouraging in its implications for small-scale pulping. However, some aspects of the inquiry required further examination; and it would be wrong to dismiss all types of small-scale pulping as absolutely impracticable until further studies had been made of such matters as roundwood yields and price and cost trends. Generally speaking, demand trends in the pulp and paper sector should favour developments in this country; but in the final analysis the question was whether raw material could be produced as cheaply in Britain as abroad.

Sandwell had, in fact, only touched the fringe of this problem, and Mr. Troup suggested that it would be in the interests of both growers and users to carry out further examination of some of the detailed aspects. Some of these aspects might be suitable for joint research between timber producers and users.

Discussion

Mr. Hiley, in opening the discussion, said that he would talk about the economics of growing timber. He still felt that their best crop was likely to be saw-timber. But what were growers to do about the large volume of thinnings which would come on the market? They had been extraordinarily lucky in having a pitwood market and, compared with other countries, had had a good price for thinnings due mainly to the national economic position, and fair dealing by the National Coal Board. We had been told repeatedly in the discussion that costs must be reduced and this was clearly a duty. He foresaw three ways in which costs might be reduced. Firstly, by looking again at the different species more carefully with a view to giving the pulp industry what it wanted. He quoted a range of Forestry Products Research Laboratory figures to show the volume required to provide one bone-dry long ton from 76 H. ft. for Sitka spruce down to 51 with European larch; Douglas fir, Corsican pine, and Japanese larch were about 61, and Scots pine 57. These averages might not be applicable to thinnings. However, if the trees were grown up to 30–40 years, not a very large proportion would be juvenile wood. If they aimed to get the biggest weight, rather than the biggest volume, per acre there was a considerable range, but nothing really competed with Douglas fir and Sitka spruce; the nearest was Corsican pine. First quality Japanese larch was

considerably below third quality Douglas fir or Sitka spruce. There were local variations in the growth of different species, and growers should consider their local opportunities.

Secondly, by reducing costs of preparation, extraction, and delivery of thinnings. We had to test methods professionally, and this could not be done unless there were some good unit of measurement—and this implied costings. Costs calculated from piecework rates for each operation were much lower than those derived from the financial accounts even when, in the latter, thinnings in hardwood and first thinnings were excluded. Overhead costs must also be brought in and, largely owing to differences in these, it was difficult to compare results from various estates, unless all the work were done on contract. From what he could see, that appeared to be the cheapest way of getting out props. Very important work was being done by the Forestry Commission on technical methods of performing operations and much had been done in Scandinavia on these lines. Reliable results would take some time to collect, and one had to cover a great variety of conditions.

Thirdly, there was scope for cost reduction by more intelligent thinning. Reference had been made to the 'Craib-Hiley' school but he would like to point out that this was not fundamentally a heavy thinning school. It was fundamentally an endeavour to do the work and produce the stuff most cheaply. Why it was associated with heavy thinning was because they had found in nearly every case that heavy thinning reduced the cost of growing. Most people believed in the theory that the grade of thinning did not materially alter the C.A.I., and this theory enabled one to calculate how fast trees would grow with heavier thinning. According to Craib's 1947 paper, thinning *Pinus patula* in his new way would give just about twice the money yield per acre per annum over a 30-year rotation as the old method. From the results of calculations, he (Mr. Hiley) thought that we in Britain should save less than this, possibly about one-quarter of the cost (even with Norway spruce quality class II which was not a particularly favourable species to take) if we thinned more sensibly. His basis of comparison was the Forestry Commission yield tables and the Forestry Commission advice on thinnings which they altered in 1951 to the present yield table densities, and, he regretted to say, went on publishing as late as 1958, long after they had been shown to give unfortunate results. He was happy to learn that many Forestry Commission foresters did not thin in this way, but they seemed to have done so in his own conservancy and the result looked very unreasonable.

He had his doubts about the suitability of his own area (Devon) as a site for a pulp or chipboard mill as the yield there would not be big enough. Chipboard and pulp mills were likely to be built in areas where there was a large proportion of land under forest; and these outlets might draw off thinnings and so leave more of the pit-prop market for less fortunate areas. He thought that what they had to do in his area was to grow timber in such a way that they produced as few small thinnings as possible. Mr. Ryle had said that about 70 per cent. of our output was thinnings, and about 30 per cent. saw-timber, but Mr. Hiley hoped that they could do better than that if they tried, especially in the fast-growing areas. They would have to work out how to do it.

Mr. Grayson emphasized the dynamic aspects of the problem of quantities, prices, and costs. Sandwell's approach was 'static'. Yet the total prospective output was a relatively small proportion of total demand even by the end of the century (5 million acres would produce about 400 million H. ft. per annum and demand might be more than the present 1,100 million H. ft. approx. roundwood equivalent). He also referred to demand and supply relationships for possible new and existing markets, and the questions of specifications, quantities required, and the prices offered. There was need for more demand projections in established markets, and here mining timber was the most important field. He then went on to discuss costs of production of pulpwood. While future prices at various levels of demand by users of the smaller size classes of roundwood were incapable of any precise prediction, the comparison of likely prices with costs of production was clearly of importance. The determination of cost of producing a more or less homogeneous material like pulpwood, where price was not greatly influenced by size, was much simpler than in uses where different sizes of tree were reflected in differing prices. He made a comparison of cost per H. ft. standing for Norway spruce quality class II under two different régimes, and concluded that a régime specifically designed to provide small-sized roundwood could yield produce at a cost approximately equal to the prices at present paid for thinnings from a stand grown to provide sawlogs of much higher values. Whether the cost of production (at 4 per cent. interest or some such rate) was minimized using the rotation and the species which together provided the maximum weight of bone-dry fibre was another question, and available information was not sufficient to answer this point. The greater the weight concentration, the lower would be the transport cost.

On exploitation, collaboration with the Forestry Commission work study section would yield useful results on the factors influencing costs. Costing need not, it was felt, be such a laborious matter with constant concern for comparability of conditions because the use of regression analyses would almost certainly enable rather diverse sets of conditions to be handled together. His impression was that cost reductions were likely to be greater for a smaller proportionate change in average tree-volume handled than in volume per acre cut, but assessment of the effect using the right equipment and organization for heavier cuttings was vital.

On the demand side one was led again to believe that the study of prices and their trends in the final markets was essential if we were to gain any idea of prices payable for the raw material.

Mr. Grayson went on to examine the relative attractiveness of large- and small-scale wood-using industries—the former including pulp and board mills and the latter sawmills. He distinguished seven aspects and referred to some of their implications:

1. The shorter rotations possible in forests supplying small roundwood: flexibility; reduction of risk and uncertainty as against possible loss of increment.

2. The physical potential of trees ordinarily cultivated for sawmilling: faster girth growth, relative to Scandinavia, and relatively scattered distribution of forests.

3. The type of forest likely to be engendered to give a homogeneous product: effect on amenity.

4. The effect of increasing demands by pulp and board manufacturers: greater certainty of demand for wood raw material used; effect of law of comparative advantage tending to locate pulp mills in heavily forested regions, apart from those integrated with saw-mills tending to 'mop up' some highly valued production from smaller areas; possible effect of freer trade on pulp and board industries.

5. The relative capital requirements: large-scale pulp mills required an investment of about 10*s*. rising to 15*s*. per H. ft. of yearly intake; in sawmills the cost was about one-fifth of this.

6. Employment in areas of redevelopment: with sawmills employing more men per H. ft. of intake.

7. National economic rewards to the different investments; e.g. relative dependence of paper industry on imported material, productivity of capital in the pulping and sawing industries.

Mr. Grayson concluded that while a specially designed pulpwood régime might yield (at current market prices for wood) comparable returns with the more normal régime producing small wood plus sawlogs, a great number of other factors must be considered besides the purely forestry production issues. Clearly some geographical circumstances strongly favoured large-scale industries, and the question whether we should grow primarily for pulpwood or sawlogs was itself too general to be meaningful. Further economic and technical investigation was most desirable on both the forest and the demand sides (for pulp products and sawn products) if we were to achieve the most advantageous use of our resources.

Mr. Richards said that he would give Mr. Hiley some facts. The impression might have been created that the work-study section of the Forestry Commission was mainly concentrating on the improvement of certain tools and certain details of the working methods. This was not so. The scope of the work was much broader —to improve the efficiency of logging operations generally—and the approach had been a comprehensive one, the various operations being costed in the way which Mr. Hiley had suggested was desirable. The Forestry Commission had a good connexion, through the active Joint F.A.O./E.C.E. Committee on Forest Working Techniques, with those in other countries interested in increasing efficiency and output. Much help had been obtained from its members. The subject of forest roads had been mentioned and it was hoped that two of the Committee's leading members would be able to visit Britain and to give their views on the economics of using cableways as an alternative to (secondary) forest roads in certain areas. Both these men, although working in research institutes, had had wide experience in erecting and operating cableways under many different conditions in Europe.

Mr. Richards also mentioned that F.C./F.P.R.L. investigations would give full information about the specific gravity and fresh-felled moisture content of home-grown softwoods of pulpwood size.

Dr. Frankel said that everyone liked to have the position where there was

competition for his produce. A pulp mill could not exist other than on a very large scale, and therefore the growers, State or private, had to make up their minds whether they were going to permit 'nibbling' or not. The Outer Seven proposals had no bearing on pulp mills but they did on board mills; he felt that once the agreement was signed, the 10-year period for spreading out its application would be reduced. He had hoped that Mr. Hiley would tell them something about the economics of thinnings and the main crop. When you allowed for compound interest the price for main crop was worse than for thinnings which were now likely to be the main crop. He agreed with Mr. Hiley that timber should be the main object of forestry, and he was not on the side of clear-felling small trees except perhaps where the conditions made it uneconomical to grow saw-timber. When only a small proportion of pulpwood was produced, perhaps they would stop trying to get high prices for it. In their thinking about a Fort William mill they should note that its products would be carried by boats all round Britain and these would pick up return loads from forests which might otherwise be remote from markets; this might make softwood profitable in areas where it was not profitable to site even the smallest chipboard mill. He had seen many different calculations in different countries comparing the yields in bone-dry weight per acre of fast- and slow-growing, and heavy and light species. The result was quite clear: that the faster a tree grew by volume, the greater was the bone-dry weight produced per acre. Douglas fir might be the real competitor to spruce, and they were all in favour of it.

Mr. Hiley felt that it was not possible to answer whether thinnings supported the main crop or vice versa, since this was an example of joint production cost. He did agree that there were many places where pit-props were so profitable that it was worthwhile not to produce saw-timber at all.

Mr. Troup disagreed with Dr. Frankel over the potential effects of the Outer Seven on British or any other pulp industry. He thought that any reaction which affected the paper industry would inevitably affect pulp also as the two were so closely interrelated. His view was that on balance freer trade might tend to encourage pulping development in Britain, but on the other hand one had to recognize the difficulties that both he and Dr. Frankel had indicated earlier.

VI. SUMMARY

By K. N. RANKIN

1. *One Industry*

ARISING from the foregoing discussions, there was a clear need for all of us to see ourselves as one industry, composed of the growers, the sawmillers, and the processers. The need was for over-all planning as one industry and for the utmost efficiency in all sectors of the industry if we were going to become competitive by world standards.

2. *Objects*

The objects of our planning had to be:

(*a*) 100 per cent. utilization of the forest product; and

(*b*) the highest return on the capital employed in the industry.

3. *Pattern of Production*

If we were to achieve the objectives that we had set ourselves we had first to examine the picture, maybe 50 years ahead, when we should have 5 million acres of productive woodlands and forests. We could examine the probable annual output of the forests and see what industry was required in support. In the meantime we could build up these required industries steadily over the years as the forests became more productive. Five million acres of woodland could be expected to produce 420 million H. ft. per annum. One-third to the sawmillers would give them a raw material of 140 million H. ft., and two-thirds to the board- and pulp-mills would give them 280 million H. ft. per annum. One-half of this production would be concentrated in Scotland and would be almost entirely softwoods. The remainder would be in England and Wales, and might be 20 per cent. hardwood approximately and 80 per cent. softwood. There would thus have to be a rather different pattern of production and industrial capacity in England and Wales.

The sawmillers asked for a constant flow of millable timber at the rate of ½ million cu. ft. per annum for a really efficient modern sawmill. The boardmillers asked for 3 million cu. ft. per annum, and the pulpmillers wanted 15 million cu. ft. per annum. We also had to allow something for mining timbers, transmission poles, &c., but when production was on this kind of scale, these other industries would be relatively subsidiary.

We could thus see that an area of forest of 400,000 acres within a reasonable geographical radius would be about an economic unit, giving 32 million cu. ft. of production to support eighteen sawmills to take 9 million cu. ft. and one full-sized boardmill, with one full-sized pulpmill. All these industries would thus take 27 million cu. ft. and leave a margin of 5 million cu. ft. for other outlets.

In Scotland there would be room for six integrated forest and factory units on this scale, and in England and Wales there would be a call for six similar industries, although not necessarily quite the same, having regard to the different forest

products. In England and Wales, particularly in the south, and giving 20 per cent. of the acreage to hardwoods, there could be 480,000 acres of hardwood, giving a production estimated at 24 million cu. ft. per annum. This might be some consolation to Dr. Frankel when looking forward to see the possibilities of maintaining supplies for his hardwood pulpmill at Chepstow.

There was a need for us to support those who put down large sums of capital to set up much-needed forest industries. We had to assure them of a constant flow of uniform raw material at an economic price.

4. *Pulp and Paper*

World consumption of pulp and paper had doubled in the 20 years to 1956, and it was still increasing at the rate of 7 per cent. per annum. The rising world population and the rising standards of living would give rise to huge new demands for pulp and paper. If supplies could not keep pace with this increasing demand, there was a fair prospect of rising prices.

There had also been a revolution in the packaging trade which might bring huge new demands for pulp and paper products.

5. *The Timber Growers*

We had to aim at the production of as much saw-timber as possible, as it was more profitable to us than anything else, and at getting it at the earliest date.

We had to give attention to genetics to ensure that we got the tree that gave us the right results. Spacings could in general be rather wider than in the past, 6–8 foot spacings being often appropriate. We had to follow heavy thinning régimes and use fertilizers, especially if we now thought that the low-quality juvenile wood was related to distance from the pith and not to age of the tree. There had to be a sound management plan to cut down the costs of management, as with other costs, and it was now generally agreed that 10,000 acres of productive woodland under one management was about appropriate. We had to have fully adequate roads and rides throughout our woodlands and, at £20 per acre, this would call for a national investment of £100 million for roads to serve the national forest. There was a need for a new grant for the private woodland owner who could not find the capital to build his roads. In a competitive world we had to grow for quality, and early high pruning of the selected final crop became of much importance.

It seemed generally to be agreed that we should aim at producing timber with about 6 rings to the inch and there was no particular harm in many cases in growing quicker than this. Inevitably there would be a considerable quantity of slower-grown timber, to give 8 rings to the inch or more, for use as joinery timber. We should give, however, more attention to securing an even rate of growth rather than a quick rate, as this would give us better quality. There had been a change of opinion since the debate at Northerwood last year, and most people were now thinking of producing softwoods for quality as well as quantity. There was evidence of a much increased price available in the industry for the wider and longer specifications. Sawn timber of 16-foot lengths and up was today really valuable. Good quality softwood trees of large quarter girth sometimes commanded prices

three times as high as the smaller trees. All this suggested that high pruning in stages up to 24 feet (or even 30 feet) was desirable.

There was a call for the elimination of operations in the forest that could more cheaply be carried out in the mill or factory. The forester should concentrate on getting his timber out of the forest and delivered into the mill at the lowest possible cost, leaving cross-cutting, debarking, and chipping to be carried out in the mill. This approach to the problem would be likely to effect over-all savings of cost. There was a paramount need of proper supervision and control in the forests to save costs at all points. The value of the highly trained forester could not be over-estimated in our industry.

Extraction and delivery costs were greater than the costs of growing timber. This was therefore a subject to which we should all give a great deal of attention.

The grower could not be expected to agree to clear-felling his crop at 30–40 years, except perhaps in remote and difficult areas where thinnings would be quite uneconomic. By clear-felling at that age, the owner was being deprived of his main expectation. In the following 20 years he could reasonably expect to double the volume of his crop and to double the price per unit, with a resultant four-fold increase in his capital. To him it was in the nature of a heresy to be asked to fell his crop at 30 or 40 years.

The two-storey crop still seemed to provide the best of several worlds, especially as it removed the awkward sized timbers which were too big for the mining specifications and too small for efficient sawmilling.

Last year at the Conference it was agreed, concerning our industry as a whole, that 25 per cent. was a growing problem, 25 per cent. a manufacturing, and 50 per cent. a selling problem. We must therefore give much more attention to the needs of the customer, and the customer was demanding Norway spruce, Sitka spruce, Douglas fir, and Scots pine. It was becoming evident that the greatest demand was for the spruces, but that Scots pine could be run really profitably if grown for quality. We had produced excessive quantities of Japanese larch, which might be difficult to market, and both the larches would be likely to go out of favour in future plantations.

Mixed plantations on high-quality sites would be profitable and we had the excellent examples of Lord Bolton's and Mr. Ackers's work which would be likely to appeal to many people in private forestry.

6. *Conclusion*

The need was for enterprise as well as for efficiency. Why, for example, should we not export our products, and why should we not have vertical integration as well as horizontal integration in the industry? A furniture industry could be set up alongside a chipboard mill, which itself was alongside a sawmill.

Our country needed to export to live, and we did better exporting manufactured goods than raw materials. We were already exporting sleepers to the continental railways, even though British Railways would not accept them, and Mr. Pritchard had already confirmed that there was no reason why the furniture industry should not export its products, particularly to America.

LIST OF THOSE WHO ATTENDED THE DISCUSSION MEETING

Forestry Commission

Mr. C. Barrington
Mr. C. D. Begley
Mr. M. A. Colley
Mr. D. J. Cooper
Mr. T. W. G. Coulson
Mr. H. L. Edlin
Mr. J. M. Gill
Mr. A. J. Grayson
Mr. M. G. Harker
Mr. J. Jobling
Mr. E. A. Keen
Mr. M. J. Penistan
Mr. E. G. Richards
Mr. G. B. Ryle

Private Forestry

Mr. C. P. Ackers
Mr. N. H. Gore
Mr. R. M. Harley
Mr. W. E. Hiley
General Howard Jones
Major S. F. Macdonald Lockhart
Mr. J. Maxwell Macdonald
Mr. A. B. L. Munro-Ferguson
Mr. G. E. H. Palmer
Sir Richard Proby
Mr. K. N. Rankin
Mr. W. Seymour
Mr. D. A. West

Industry

Mr. C. E. Budden
Mr. G. E. Edwards
Dr. T. H. Frankel
Mr. B. C. Hollingsworth
Mr. F. C. Lynam
Mr. C. G. R. Maynard
Mr. J. C. Pritchard
Mr. G. W. Troup
Mr. J. Venables

Universities and Research Institutions

Dr. L. Chalk
Sir Harry Champion
Mr. D. Kinloch
Mr. J. J. MacGregor
Mr. W. M. McNeill
Mr. L. G. O. Pearson
Mr. B. J. Rendle
Mr. K. G. Stott

Consultants

Mr. C. M. Harris
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PRINTED IN GREAT BRITAIN
AT THE UNIVERSITY PRESS, OXFORD
BY VIVIAN RIDLER
PRINTER TO THE UNIVERSITY